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ABSTRACT

This PTC'97 volume contains papers presented at the 19th annual conference of the Pacific Telecommunications Council, "Pacific Connections: Policy and Technology in the Information Economy" (1997). Three super-session groupings--industry, policy, and technology--provide attendees with a conceptual foundation from which subsequent concurrent sessions are offered: applications/users, social/cultural, industry, development, technology, and executive focus. This volume offers more than 140 papers, arranged chronologically according to date of presentation. Topics include: network-based currencies; teletext technology and stock markets; telemedicine; interactive communications policies; telecommunications in disaster management; telecommunications in developing countries; global systems regulations; wireless networks; integrated management systems; global connectivity; satellite television; telephone services; multimedia technologies; nation-wide research; distance education; electronic tourism; Asynchronous Transmission (ATM) switching systems; electronic banking; competition; strategic international alliances; information economy; rural networks; public telephony; digital television; online services; virtual colleges; technology trends; reinventing education; cellular networks; standards for secure subsea telecommunications cable systems; private investment ventures; intelligent agents; Web searching; outsourcing; and industry development. (Includes subject, country, and author indexes.) (AEF)

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ED 419 487

19th Annual
Pacific
Telecommunications
Conference

Proceedings

Edited by Dan J. Wedemeyer and
Richard Nickelson

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Foreword

Welcome to **"Pacific Connections: Policy and Technology in the Information Economy"**, the Pacific Telecommunications Council's nineteenth annual conference.

As our high-quality meeting standards have established, PTC'97 has again sought to organize a rich and highly rewarding information environment which encourages the introduction and testing of new ideas. This particular PTC forum sets out a panoply of perspectives from academic, business and government and presents these perspectives in three refreshing new daily formats.

Specifically, you will be able to select from three super-session groupings-- industry, policy and technology-- on Monday and Wednesday. Each of these will provide attendees with a conceptual foundation from which subsequent concurrent session choices can be made during each of the three conference days. Six concurrent sessions, Applications/Users, Social/Cultural, Industry, Development, Technology, and Executive Focus, are offered this year.

PTC'97 offers more than 140 papers selected from 325+ paper submissions. This year, as in the past, seventeen (17) reviewers, organized in four review tracks, have made their "blind-review" selections. In order to help you select and locate specific papers the '97 *Proceedings* contents have been organized using two indices, *subject* and *country/region*.

Using these indices as a basis for analysis, we have detected some interesting topic patterns. Specifically, some of the highest ranking subject categories are Internet, distance education, GII, ITU, network architecture/management, convergence, regulatory shifts, development issues, PSTN and various advanced satellites--mobile, VSAT, etc. Country and Regional foci were highest for China, Australia, Indonesia, Malaysia, Hong Kong, Singapore and Pacific Islands.

The Pacific Telecommunication Council's annual conference is a rich and delicate balance between tradition and anticipation. The traditions focus on excellence and collegiality and are operationalized in the quality of organization, information and interaction. The anticipation component is essential to understanding and to harnessing the energies and dynamics of the emerging convergence environment. The levels and richness of each are obvious within and among conference participants and the PTC conference committee and the PTC staff. We owe a debt of gratitude to these professionals and for the financial support from AT&T Submarine Systems for this volume, and to all our members and sponsors for their support.

Finally, we want to wish you the best of PTC'97 conference experiences.

Aloha,
Dan J. Wedemeyer
Richard Nickelson
Honolulu, 1997

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"Worldwide Probe of the Telecommunications Development Gap From Developing Country and Developed Country Perspectives"

(See Following Pages)

Worldwide Probe of the Telecommunications Development Gap From Developing Country and Developed Country Perspectives

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1. ABSTRACT

Despite increasing enthusiasm for the development of regional information infrastructures or even the global information infrastructure, there still is a gap of telecommunications capability between developed countries and developing countries. The study examined the nature of the telecommunications development gap and obstacles to efforts advancing telecommunications in developing countries. It also identified strategies to overcome many of the obstacles. The study solicited a variety of perspectives of telecommunications professionals from approximately 70 countries by using an iterative international survey.

2. INTRODUCTION

Related to the rise of the new knowledge-driven economy, Toffler (1990) discusses some negative economic impacts of its arrival on developing countries (hereafter referred to LDCs). He identifies three distinct groupings among LDCs:

> One consists of desperately poor countries still mostly dependent on First Wave peasant labor. Another group includes countries such as Brazil, India, and China. These countries are actually important Second Wave or industrial powers, but saddled with vast populations still scrabbling for subsistence from preindustrial agriculture. Lastly, there are nations such as Singapore, Taiwan, and South Korea; which have virtually completed industrialization and are moving swiftly into Third Wave high technology. (pp. 383-384)

He explains that once advanced countries such as Europe, Japan, and the United States developed highly value-added products by effectively utilizing computers and telecommunications they transferred many of the less information-oriented tasks to certain less developed countries. This resulted in the speedy industrialization of such countries as South Korea, Taiwan and Singapore. These countries then passed off those tasks to more economically backward countries while they made the transition to more information-intensive economies (p. 387). Many LDCs, however, have not made the transition from less information-intensive economies to information-intensive economies, and as a result, they lag behind the rest of the world in overall national development. Lee (1995) finds that while more than three-quarters of developed countries (hereafter referred to DCs) invest in the modernization of their wired networks and in the extension of wireless networks, many of LDCs spend almost two-thirds of their investment on constructing basic wired networks (p. 2).

Toffler sees a growing disparity of the world into two groups:

> .... from now on the world will be split between the fast and the slow. .... In fast economies, advanced technology speeds production. .... Their pace is determined by the speed of transactions, the time needed to take decisions (especially about investment), the speed with which new ideas are created in laboratories, the rate at which they are brought to market, the velocity of capital flows, and above all the speed with which data, information, and knowledge pulse through the economic system. Fast economies generate wealth - and power - faster than slower ones. (1990, p. 389)

Information and knowledge, key factors of the new economic system, have suppressed the values of the three key factors of production of the agrarian and manufacturing economic systems: labor, capital and land. The dramatic economic growth, supported by the shift toward information-oriented economies in Newly Industrialized Economies (NIEs) such as South Korea, Singapore, Hong Kong and Taiwan, is the result of their awareness of the superior power of the new economic system as well as their coordinated efforts to catch up with the most advanced economies (Choi, 1992; Kim, Kim, & Yoon, 1992; Kuo, 1993; Kyong, 1995; Naya, 1988; Parapak, 1994; Ure, 1993, 1995a). Many of the LDCs still heavily dependent on labor-intensive agrarian manufacturing economies are at a considerable disadvantage concerning their economic capability in the world.

The new system for generating wealth depends on an instant communications network through which data, information and knowledge flow. An adequate telecommunications infrastructure and services are essential for any nation to play an important role in the world economy. Those LDCs that do not have adequate telecommunications are in danger of being economically exploited by the rest of the world.

The fast and slow could be exemplified in the level of teledensity (telephone lines per 100 inhabitants). While the least developed countries have increased their level of

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teledensity from 0.19 to 0.29, a 150% increase, those LDCs which are slightly more developed, for example China, India, Egypt and Pakistan, have increased teledensity from 0.31 to 1.21, a 400% increase, over the last decade (Kelly, 1995, p. 3).

Underdevelopment in telecommunications in LDCs and the resulting information imbalance also intensify social divisions in the world. Hamelink (1995) indicates that most of the world's information moves among DCs and information between DCs and LDCs tends to move one-way from the former to the latter (p. 298). A hundred times more news, mostly about DCs, flow from DCs to LDCs; information about natural resources in LDCs is collected by satellites of DCs; DCs' sophisticated military surveillance networks cover LDCs. This situation is attributed to the LDCs' inability to produce, distribute, and access relevant information (Hamelink, 1995, pp. 298-301). He points out four disadvantages of LDCs caused by the information imbalance: inadequate information capacities hinder LDCs' efforts to overcome poverty, malnutrition, poor health and other problems; LDCs are continuously at a disadvantage in international negotiations with DCs; the national sovereignty of LDCs is threatened by DCs that own much information about LDCs; the preservation of cultural heritage and cultural self-determinism in LDCs are undermined by the huge inflow of cultural information from DCs (pp. 304-305).

Given these negative consequences, few would accept the current conditions of telecommunications in LDCs as they are. Casmir (1991) states that the reality of a border, which stems from the state concept, disappears because of worldwide information flow (p. 24). As these borders disappear, what were once problems confined by national boundaries become worldwide in nature. As more countries move toward information-centered economic systems and societies, the advancement of telecommunications capability worldwide becomes more critical.

Given this state of affairs, why do many LDCs still lag in infrastructural development? What has prevented them from advancing their telecommunications capabilities? What should be done to remedy the existing unfavorable conditions in LDCs? These are the questions that will be investigated in the study.

The following sections are organized as follows. Section 2 reviews selected literature on the nature of the telecommunications development gap, obstacles to telecommunications development and strategies for overcoming the obstacles. Three research questions are elaborated and more explicitly stated in the section. Section 3 discusses an international survey as the study's research methodology. Sections 4, 5 and 6 summarize the results of the survey for each of the research questions. Section 7 discusses the contributions of the study and Section 8 points out its implications.

3. LITERATURE REVIEW

3.1 Nature of the Telecommunications Development Gap

The first research question in the study is: "What is the nature of the telecommunication development gap?" Much effort has been expended to promote telecommunications development in LDCs through various types of development projects initiated by LDCs and/or DCs. Some efforts are effective, but others are not. Breiner (1992) states "It is therefore disappointing to find that many telecommunications projects have in the past frequently fallen short of their objectives" (p. 445). Jamieson (1991) analyses the lack of success as follows:

> Change is being promoted in the name of development without any possible certainty as to its ultimate social and environmental outcomes. ....The combined and sometimes interactive effects of multiple projects in a region or a sector, probably undertaken independently, may come as a complete surprise. This is why many development programs fall far short of the original expectations and some even do more harm than good. (p. 31)

One probable cause of the failure is presented by Uphoff (1985) as " .... too much effort goes into trying to find out what is wrong with the people who don't adopt the technology and too little effort goes into finding out what is wrong with the technology ...." (p. 38). These analyses illustrate that development efforts with incorrect assumptions about the problem and without clear goals cannot hope to achieve desirable outcomes. The same hold true in telecommunications development. What is needed first is to examine the problems that many LDCs have faced and identify the critical dimensions of these problems. As long as new development projects are initiated without understanding the critical dimensions of these problems, not much improvement can be expected from these projects.

The current study aims at examining problems of telecommunications development in LDCs and identifying the critical dimensions. The first step is to thoroughly investigate what the term telecommunication development gap means.

Several descriptors are used to depict the status of telecommunications development in LDCs. Some examples are missing link, disparity, imbalance and gap. The word gap will be used in the study as a composite of what each of these words represents.

The Maitland Commission (1984) described the gap as unbalanced distribution of telephones across the world, low teledensity, shortage of exchange capacity, length of the waiting period for acquiring a telephone line, low quality service and imbalance of telecommunications infrastructure between urban and rural areas. The ITU (1994a) uses national teledensity, the relationship between a country's population and the number of main telephone lines, the distribution of telephone lines within a country and poor quality of service. The Secretary-General of the

ITU stated that the gap existed not only in quantitative terms but also in qualitative terms (Tarjanne, 1994, p. 9).

As the above examples show, dimensions of telecommunications problems depicted by the term gap vary extensively. When the term gap is used in the literature or orally to reflect the problems of telecommunications development in LDCs, only a few of the dimensions of the problems are examined at a time. In order to fully understand the core of the problems inherent in telecommunications development in LDCs, it will be necessary in the study to comprehend the telecommunications development gap as a whole. There has been no study that has analyzed comprehensively the nature of the underdevelopment. The current study will aim at forming a framework to fully grasp the nature of the gap by identifying the dimensions of the gap. Thus, the first research question in the study is stated as "what is the nature of the telecommunication development gap?"

3.2 Obstacles to Telecommunications Development

While many studies have addressed the probable obstacles to telecommunications development in LDCs, they discuss only some of the existing obstacles. In addition, the focus of these studies is on LDCs. As a result, most obstacles have been attributed to LDCs alone. The second research question of the study, then, will concern all existing obstacles found in both LDCs and DCs.

The Maitland Commission (1984) analyzed several obstacles to closing the telecommunications development gap. They are summarized as follows:

1. Funding:
    * LDCs need more capital than they can raise themselves; and,
    * Hard currency necessary for purchasing telecommunications equipment abroad is scarce.
2. Priority of telecommunications:
    * Other sectors such as agriculture, health, education and roads get a higher priority in national budgets than telecommunications due to the lack of understanding of the catalytic role of telecommunications in development.
3. Imported equipment:
    * The design of imported equipment is less suited to the environments and needs of LDCs;
    * Manufacturers abroad stop producing old systems that are still widely used LDCs, and as a result, LDCs are forced to replace their equipment; and,
    * Different types of equipment installed over a number of years lead to difficulties in training, compatibility and maintenance.
4. Service in remote areas:
    * Various geographical barriers to remote areas as well as lower monetary returns from those areas reduce the incentives to extend telecommunications services to those areas.

These obstacles concern economic, political, technological and geographical issues.

Wellenius (1989) argued that LDCs had three obstacles to overcome. The first is the scarcity of foreign exchange, a financial obstacle. The second is the operating entities' lack of internal organization and management. And the third is insufficient autonomy of the operating entity from government. The latter two obstacles are related to organizational and policy issues.

The Secretary-General of the South Pacific Forum Secretariat expressed his concern that governments in many LDCs had been dependent on the telecommunications sector's cash flow for use in other sectors. He also stated that capital investment in telecommunications was often linked to the next available aid package (Tabai, 1994, p. 43). These problems are political obstacles to development of the telecommunications sector. Parker (1992) identified another political obstacle. He pointed out that power holders in government tended to oppose development of telecommunications fearing that the development would weaken their position. He argued that existing economic and political power holders needed to be persuaded that the development of telecommunications could be a "win-win" proposition.

In the World Telecommunication Development Report, the ITU discussed some of the most common obstacles to telecommunications development (1994a, p. 79):

1. Lack of re-investment:
    * Whereas rapid telecommunications development was achieved in countries where at least 50 per cent of telecommunications revenues were reinvested, the level of reinvestment is still low in many other LDCs.
2. Poor quality of service:
    * Outdated equipment and inadequate maintenance result in poor quality of service, leading to loss of revenues.
3. Foreign exchange scarcity:
    * Hard currency is limited due to high external debt and limited export earnings; and,
    * Foreign exchange through the international accounting rate system tends to be transferred to the central bank instead of being directly used for telecommunications development.
4. Investment inefficiencies:
    * In many LDCs, the cost of installing one telephone line is far beyond the widely used figure of around US $1,500;
    * Higher installation cost per line in rural areas hinders the extension of the network to those areas; and,
    * Such promising low cost technologies as cellular radio and VSAT (Very Small Aperture Terminal) suitable for rural areas tend to be provided primarily to urban areas.
5. Absence of universal access policy:
    * Many LDCs lack a universal access policy.

6. Inadequate private sector involvement:
    * Private sector involvement has not yet been adopted by many LDCs.
7. Insufficient regional cooperation:
    * Cooperation for regional links, pooled equipment purchases, shared training and technical specifications on equipment has rarely been fully developed.
8. Organizational limitations:
    * Because telecommunications services are provided by monopoly, government-run organizations in most LDCs, there are few incentives for better performance; and,
    * It is difficult to retain qualified staff due to low salaries.

The number of identified constraints in the report is greater than that in the Maitland Commission report. These constraints are financial, technological, managerial, economic, geographical, policy, and organizational in nature.

Regarding managerial constraints, Kyong (1995) claimed that "Experts in such fields as management, consulting, legal issues on technology, finance and policy in relation to information and communications are also in short supply" (p. 3). Moran (1994) stated that telecommunications administrations in LDCs are having difficulties making telephone service available to everyone in the country, keeping abreast in digital technology and keeping up with an ever changing environment (p. 26). These problems come from the insufficient planning capabilities of the operator and the government. Kirunda-Kivenjinja (1995) pointed to obstacles such as inappropriate organizational and managerial ability, the loss of trained staff, the necessity to adapt training materials to advanced technologies, and the difficulty of keeping up with technology (pp. 1-2). He showed that there are organizational, managerial, human-resource and technology related obstacles in LDCs.

One of the key trends in the telecommunications sector during the past decade is the shift of control, i.e., deregulation, liberalization and privatization of telecommunications entities worldwide. This trend was triggered by the divestiture of AT&T in the United States and the privatization movement in the United Kingdom in the early 1980s. Regardless of this prevailing trend and the notorious structural problems of government-operated telecommunications entities, many LDCs have not yet changed how they provide telecommunications services. The former Deputy Director General of India's Department of Telecommunications stated, "Most of these reforms are opposed by the government departments providing telecommunication services in many LDCs, ..." (Chowdary, 1992, p. 593). Such resistance to change can be an organizational hindrance to telecommunications development in LDCs. In addition, Pisciotta (1994) states that significant resistance to reform comes from national security concerns (p. 29). This is a political obstacle to reform.

Saunders (1982) presented the following constraints to telecommunications growth in LDCs, addressing organizational, political and policy obstacles (pp. 195-200):

1. Inadequate efforts by telecommunications entities to achieve a higher national priority for the telecommunications sector;
2. Lack of understanding among planning and finance ministers of the significant importance of telecommunications;
3. Telecommunications pricing and investment policy not analyzed together with national investment policies;
4. Incorrect perception that rural public telephone service is unprofitable; and,
5. Insufficient financial and management autonomy of the operating entities.

While all the above obstacles exist in LDCs, Hudson (1983) presented one obstacle attributed to DCs. She pointed out that international development institutions charged with assisting LDCs had not well understood the role of telecommunications for LDCs. She argued that those institutions were inclined to regard telecommunications as an urban luxury and their loan requirements tended to ignore services in rural areas (p. 293).

The preceding discussion leads to two conclusions regarding the existing literature about obstacles to telecommunications development. First, there has not been a comprehensive examination of the problem. Secondly, unequal attention has been focused on LDCs and DCs in discussions of obstacles to telecommunications development in LDCs.

As to the first point, while the literature review has made it clear that a variety of obstacles exist, it has also revealed that each study discussed only a few of all the existing problems. No study attempted to comprehensively examine the whole gamut of the obstacles. Furthermore, it is not clear whether certain obstacles have a relatively greater negative impact on the development of telecommunications than others. Few studies have examined the relative negative impact of each obstacle. Therefore, it is necessary to comprehensively investigate the full range of the possible obstacles and their relative impacts.

Regarding the unequal attention toward LDCs and DCs, many studies have argued that LDCs possess many constraints that can only be attributed to LDCs themselves. Not much attention, however, has been paid to the possibility that DCs might be responsible for some of the constraints to telecommunications development in LDCs. This question will be addressed in the study. Thus, the second research question of the study will concern the fullest range of the existing obstacles found in both LDCs and DCs.

So far the characteristics of the obstacles identified above are policy, economic, financial, managerial, organizational, technological, political and geographical.

Bernt and Weiss (1993) group international telecommunications issues into four categories: regulatory, organizational, economic, and technical. Regulatory issues include monopoly versus competition, deregulation, privatization and tariff structures; organizational issues concern operating entities and international/regional telecommunications-related organizations; economic issues include accounting rates, pricing and standards; technical issues concern telecommunications technologies. Since the characteristics of the previously identified obstacles fall into these four categories of international telecommunications issues, the four categories will be used as a basic framework to examining the whole gamut of possible obstacles.

3.3 Strategies to Overcoming the Obstacles

Equally important to an analysis of the obstacles to telecommunications development is an analysis of strategies to overcome them.

Much research has been carried out to study the "current status" or the "recent progress" of the telecommunications sector in selected LDCs. Hukill and Jussawalla (1991) examined the current condition of telecommunications in ASEAN (Association of Southeast Asian Nations) countries. Jussawalla (1992) surveyed the progress of telecommunications development over the past decade in a number of countries in Asia, the Pacific, Latin America, Arab and Africa. Ogden (1995) examined some of the global telecommunications trends in the context of Pacific Island developing countries. Ure (1995a, 1995b) researched recent telecommunications development in such Asian countries as Brunei, Burma, Cambodia, China, Hong Kong, Indonesia, Laos, Malaysia, the Philippines, Singapore, South Korea, Taiwan, Thailand and Vietnam. These studies were very informative in presenting the historical development and the current standing of telecommunications in selected LDCs. They do not, however, indicate what strategies were used to overcome certain obstacles.

This does not mean that few studies have proposed strategies. In fact, many studies have identified or suggested a variety of strategies to advance telecommunications in LDCs.

Regarding policy and regulation related strategies, Ras-Work (1995) advocated the BOT (Build Operate Transfer) scheme as an alternative to privatization of the government operator in LDCs. Kelly (1995) regarded the new licensing policy for cellular operators and international gateways in the Philippines as the primary factor that brought the dramatic increase of main lines in 1993 (p. 4). Gatica (1994) attributed the growth of the telecommunications sector in Chile to a new legal framework adopted by the government (p. 35). In order to promote investment from the private sector and alleviate risks born by private operators, Sekizawa suggested policies such as the establishment of an independent regulatory body, securing fair interconnection among operators and securing a minimum return for private operators (1995, p.4). In Tanzania, Kiula (1994) suggested that "sector restructuring and commercialization should first be implemented and privatization should be introduced where feasible" (p. 37).

Regarding the reform of policy and regulation, Harrington (1995) surveyed a number of telecommunications reforms taking place in the Asia Pacific region and argued that the restructuring of the telecommunications sector in LDCs should be a way to attract capital to promote the growth of telecommunications. While admitting the importance of restructuring the telecommunications sector, Ure added that reform should proceed with a clear vision of national economic development (1993, P. 5).

As to technology related strategies, Harrington discussed the advantages of a wireless access network (1995, p. 5). Cutler (1994) also advocated the use of wireless technologies in the local loop (p. 6). Kiula (1994) warned that LDCs should avoid use of obsolete technologies and non-standardized equipment from DCs (p. 37). Regarding local manufacturing, Olanrewaju (1995) argued that local manufacturing capability would ensure rapid development of telecommunications services in LDCs.

The link between obstacles and strategies, however, was never explicitly examined in these studies. These studies proposed strategies without clarifying the targeted obstacles. Also, each study focused on parts of the whole problem related to telecommunications underdevelopment and suggested strategies for a limited facet of the problem. In addition, not many studies suggested strategies to be taken by DCs. This is consistent with the fact that many studies have attributed obstacles only to LDCs. No research has been done to investigate globally what strategies LDCs and DCs have been taking and should take to resolve many of the obstacles to telecommunications development. Thus, the third research question of the study is stated as "what strategies should we take to close the gap."

In summary, the literature review in this section indicates that there have been few studies that comprehensively examine the nature of the telecommunications development gap. Few studies have critically investigated obstacles to telecommunications development and various strategies to narrowing the gap. The study is aimed at answering these three questions, and as a result, expects to contribute to knowledge about telecommunications development in LDCs.

4. ITERATIVE INTERNATIONAL SURVEY

4.1 Survey Design

In order to investigate the issue of the telecommunications development in a comprehensive manner, a variety of perspectives of telecommunications practitioners was solicited by using an iterative three-round international survey. The three-round international survey was administered by developing a different questionnaire for each round. The first-round questionnaire was designed to investigate the nature of the telecommunications development gap and to identify existing obstacles that had prevented the gap from being narrowed. The second-round questionnaire aimed at measuring the criticality of each of the obstacles identified in the first-round questionnaire and soliciting current and future strategies to overcome some of the most critical obstacles. The third-round questionnaire was designed to elaborate further the strategies identified in the second-round questionnaire.

The iterative survey design used in the study is summarized in Figure 1.

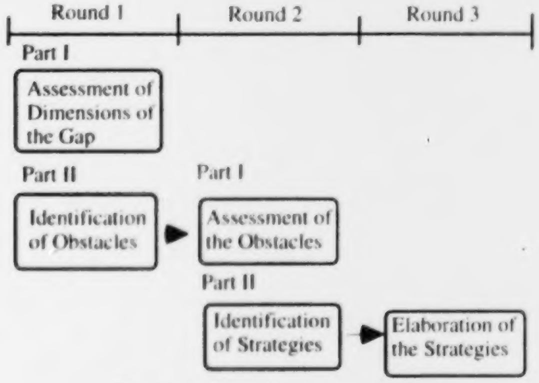
Round 1
Round 2
Round 3
Part I
Assessment of Dimensions of the Gap
Part II
Identification of Obstacles
Part I
Assessment of the Obstacles
Part II
Identification of Strategies
Elaboration of the Strategies

Figure 1. Iterative survey design.

4.2 Survey Participants

The survey participants in the study were the national delegates as well as representatives of international and regional organizations and agencies to the ITU World Telecommunication Development Conference, held in Buenos Aires, Argentina, in March 1994. A list of the delegates was obtained from the Pacific Telecommunications Council in Hawaii directly upon the conclusion of the conference. Most of the delegates, except for those coming from international and regional organizations, were government officials and telecommunications professionals in the private sector.

While over 900 delegates attended the conference, the present study used the officially listed 752 delegates as a source of possible participants in the survey. It was noted that some countries sent 20 or 30 delegates and others sent less than ten delegates to the conference. In order to avoid dominance of certain countries' participants in the pool of survey participants, around ten delegates were selected from those countries of which number of delegates were 10, 20 and 30 and most or all of the delegates were selected from those countries of which the number of delegates were considerably small. As a result, the present study selected 410 participants as a representative sample of all the listed 752 delegates. In narrowing down the number of survey participants, it was ensured that the selected delegates' affiliations would represent a balance from the public to private sector.

The first-round survey was carried out from September through October 1994. The second-round survey was conducted from November 1994 through January 1995 and the third-round survey was administered from February through March 1995. The return rate for each round was 23.3, 23.0 and 53.8 % respectively.

In the following sections, origin of participants are classified into two groups, DCs and LDCs. While there may be several ways to group countries into DCs and LDCs, this study will refer DCs as countries that are members of the OECD (Organization of Economic and Cooperation for Development) and LDCs as non-members. Approximately half of the respondents were from DCs and the other half were from LDCs in each round.

5. NATURE OF THE TELECOMMUNICATIONS DEVELOPMENT GAP

5.1 The 12 Dimensions of the Gap

The first question in the first-round questionnaire concerned the nature of the telecommunications development gap. Twelve dimensions of the gap were provided in the questionnaire. Their definitions are shown in Table 1.

Table 1. Definitions of the 12 Dimensions of the Telecommunications Development Gap

Dimension	Description
D1	**Unbalanced distribution:** The number of telephone sets in a few DCs far exceeds those in all LDCs.
D2	**Low teledensity:** In general, teledensities in LDCs are lower than those in DCs.
D3	**Insufficient capacity**: The total capacity of networks in LDCs is not enough.
D4	**Long waiting period:** The average length of the waiting period for a telephone line is discouragingly long in LDCs.
D5	**Poor line quality:** The quality of telephone lines is poor.
D6	**Poor network condition:** Breakdowns occur frequently and faults may take a long time to get repaired.
D7	**Domestic gap:** More telephones and services are provided in certain areas than in other areas within a nation.
D8	**Limited services:** Services other than voice telephony are not extensively provided.
D9	**Lack of understanding:** The catalytic role of telecommunications is not sufficiently understood.
D10	**Unsuitable technologies:** Technologies brought into LDC's do not match their needs.
D11	**Lack of financial resources:** Financial resources necessary for telecommunications development are deficient.
D12	**Lack of human resources:** Human resources necessary for telecommunications development are deficient.

The participants were asked to assess, using a scale from 1 (not important/critical) to 7 (very important/critical), each of the dimensions as to how important/critical it was in discussing the problems of telecommunications development in LDCs. The mean scores of the 12 dimensions were computed for each group. N was 100, which was the total number of responses to the first-round survey. The results are shown in Figure 2.

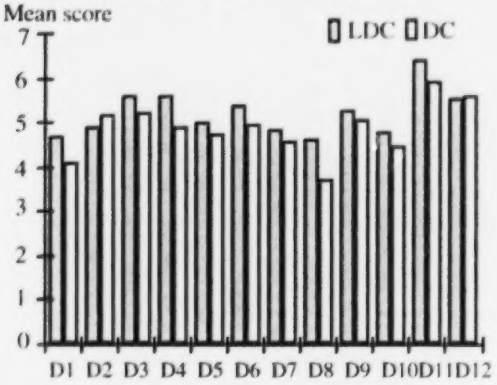

Figure 2. Relative importance of the 12 dimensions of the gap.

5.2 Similarities and Differences of the Assessment of the 12 Dimensions of the Gap between LDCs and DCs

The results of Pearson's correlation test indicated that the rank order of the 12 dimensions of the telecommunications development gap for LDCs was significantly correlated with that for DCs (F=0.855, p<.001). Thus, LDCs and DCs were generally consistent in their assessments of the relative importance of the 12 dimensions.

As seen in Figure 2, the top five dimensions to which both LDCs and DCs assigned higher scores were the following: lack of financial resources (D11); lack of human resources (D12); insufficient capacity (D3); poor network condition (D6); and lack of understanding (D9). These dimensions indicate the lack of resources and knowledge necessary to develop telecommunications.

Both LDCs and DCs were fully consistent in that they considered limited services (D8), unbalanced distribution (D1), unsuitable technologies (D10) and the domestic gap (D7) less critical compared to the other dimensions. These dimensions describe the current conditions of insufficient development of telecommunications.

The results above suggest that the dimensions indicating the lack of resources and knowledge necessary to develop telecommunications need more serious attention than the dimensions describing the current conditions of insufficient development of telecommunications

It was analyzed whether or not there was any significant difference of assessment for each dimension between LDCs and DCs. A significant difference was found between LDCs and DCs for long waiting period (D4) as well as limited services (D8). LDCs ranked the long waiting period dimension (D4) as third with a score of 5.59 and DCs ranked it as seventh with a 4.88. This significant difference probably indicates that the pressing problem of the long waiting period in LDCs is not equally understood by DCs where the waiting list for the telephone service rarely exists now. Although the limited services dimension (D8) was ranked as 12th by both LDCs and DCs, DCs gave a significantly lower score to this dimension than LDCs. Lack of a shared understanding is found in this dimension, too.

As an overall assessment, it should be noted that LDCs assigned higher scores than DCs to 10 out of the 12 dimensions.

5.3 Three Factors of the Gap

To examine characteristics of the 12 dimensions of the gap, a Factor Analysis of the dimensions was conducted. Four clusters appeared as shown in Table 2.

Table 2. Four Clusters of Dimensions of the Telecommunications Development Gap

Cluster	Description	Dimension	
1	Poor conditions of telecommunication services	D5	Poor line quality
		D6	Poor network condition
		D4	Long waiting period
2	Inappropriate technologies, understanding and human resources	D10	Unsuitable technologies
		D9	Lack of understanding
		D8	Limited services
		D12	Lack of human resources
3	Unbalanced distribution of telephones	D1	Unbalanced distribution
		D2	Low teledensity
		D7	Domestic gap
4	Lack of financial and service capacity	D3	Insufficient capacity
		D11	Lack of financial resources

Pearson's correlation test indicated that there were two distinct groups among the four clusters. Cluster 3 was not correlated with any of the other three and clusters 1, 2 and 4 were significantly correlated to one another. The first group, containing only cluster 3, seems to indicate the quantitative nature of the telecommunications development gap. That is, all three dimensions within cluster 3 are often represented by numerical values. Many of the dimensions in the second group consisting of clusters 1, 2 and 4 are usually elaborated qualitatively rather than quantitatively. Thus, the group appears to represent the qualitative nature of the gap. Furthermore, examining the characteristics of the three clusters, it can be concluded that cluster 1 indicates consequence of the problem and clusters 2 and 4 seem to point out impediment of the problem.

In order to better understand the analysis, the above observations are summarized as an analytical framework of the telecommunications development gap in Figure 3. The figure shows that the problem of the telecommunications development gap has both a quantitative and qualitative nature. It further shows that the qualitative nature is composed of impediment and consequence. As a result, three factors of the gap have appeared. A score of each factor was computed by averaging scores of the dimensions in each factor. The scores of factor 1, 2 and 3 were 4.72, 5.10 and 5.29 respectively. The result shows that the factor 3, impediment of the gap, was considered as most critical.

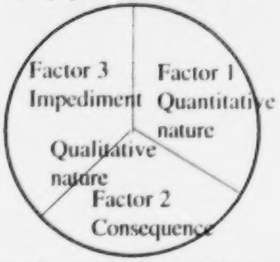

Figure 3. Analytical framework of the gap.

6. OBSTACLES TO TELECOMMUNICATIONS DEVELOPMENT

6.1 Identified Obstacles

The first-round questionnaire concerned obstacles that had hindered telecommunications development in LDCs. The survey participants were asked to suggest any obstacles in accordance with the given framework that consisted of category and origin of obstacle. Approximately 400 individual obstacles were identified. Since it was noted that the same kind of obstacle was addressed by several people by using slightly different descriptions, some work was done by the researcher to eliminate redundancy in the answers. As a result, a total of 127 obstacles across 12 categories appeared as shown in Table 3. The table presents how many distinct obstacles were identified in each category and how many of them were attributed to one of the four origins.

Table 3. Categories of Obstacles and Number of Items in Each Category

Category of Obstacle	Origin of Obstacle								
	LDCs		DCs		International/ Regional Telecommunications Organizations		International/Regional Funding/Aid Agencies		Total
	A	B	A	B	A	B	A	B	
Policy and Regulation	13	7	2	1	2	1	–	–	26
Planning and Implementation	4	1	–	1	–	–	–	–	6
Organization and Administration	5	1	–	–	3	–	–	–	9
Finance	12	5	–	–	–	–	5	2	24
Technology	7	1	–	–	–	–	1	–	9
Human resources	4	3	3	–	1	2	–	–	13
Knowledge	–	1	4	2	–	2	–	–	9
Politics	6	9	–	–	2	–	–	–	17
Economy	3	2	–	1	–	–	–	–	6
Geography	1	–	–	–	–	–	–	–	1
Social system/Culture	5	1	–	–	–	–	–	–	6
Corruption	–	1	–	–	–	–	–	–	1
Total	60	32	9	5	8	5	6	2	127

Note. The column A presents the number of items identified by LDCs and column B presents the number of items identified by DCs.

6.2. Similarly and Differently Assessed Obstacles

In the second round the survey participants were asked to read all obstacles within each category, and then assess, using a scale from 1 (not important/critical) to 7 (very important/critical), how critical each obstacle was to any effort to narrow the gap. Ono (1996) discussed an overall rank order of all the 127 obstacles and investigated the highly ranked 32 obstacles in detail.

Since the assessment of a particular obstacle by LDCs might not always be the same as the assessment by DCs, an independent t-test between the assessment of LDCs and the assessment of DCs was carried out for each obstacle. Agreement of the assessment between LDCs and DCs was found for some obstacles and disagreement was found for others. The similarities and differences of the assessments are summarized below to better understand the perceptions of LDCs and DCs.

The obstacles to which both LDCs and DCs showed a similar assessment were as follows:

* LDCs are unwilling to adapt their policies and regulations to the changing environment of the telecommunications sector and insufficiently implement liberalization of the telecommunications sector (Policy and Regulation-oriented obstacle).
* LDCs have less open, less customer-focused, less market-oriented, less responsive and less efficient bureaucratic organizations and administrations (Organization and Administration-oriented obstacle).
* LDCs have difficulty in dedicating further capital to telecommunications investment under current economic conditions (Finance-oriented obstacles).
* The funding level from bilateral and multilateral sources to narrow the gap is greatly inadequate (Finance-oriented obstacles).
* Corruption and nepotism minimize human resources development in LDCs (Human Resources-oriented obstacle).
* There is a lack of knowledgeable and impartial advice on aspects such as regulating the sector, restructuring the sector and implementing a phased program of deregulation (Knowledge-oriented obstacle).
* There is a lack of political stability in most LDCs (Politics-oriented obstacle).
* There is a continuing monopoly system and a politically motivated low-price supply of telecommunications services (Politics-oriented obstacle).
* The contributions of telecommunications infrastructure to overall economic development and to development of other sectors such as transport, agriculture, health and education are overlooked (Politics-oriented obstacle).
* The economic situation in LDCs forces the government to give a greater priority in allocating available resources to those services related to basic human needs (food, clothing, and shelter) (Economy-oriented obstacle).
* There is a problem with corruption and kick-backs (Corruption-oriented obstacle).

For those obstacles which LDCs and DCs assessed differently, LDCs tended to view them as more critical than DCs. They are as follows:

* Policies and regulations are applied from DCs to LDCs as standards or copied by LDCs without consideration of LDCs' unique needs and conditions (Policy and Regulation-oriented obstacle).
* In LDCs, the remuneration for qualified staff in government organizations is lower than in the private sector (Organization and Administration-oriented obstacle).
* The lack of sufficient financial resources seriously prevent LDCs from keeping up with changes in technology (Finance-oriented obstacle).
* There are different perceptions of how technology transfer has been conducted and should be conducted between LDCs and DCs (Technology-oriented obstacle).
* There are too many technological alternatives in the market for LDCs to choose from and these technologies are geared not for the needs of LDCs but for the commercial interests of the manufacturers in DCs (Technology-oriented obstacle).
* International and/or regional telecommunications organizations usually do not collaborate in human-resources promotion (Human Resources-oriented obstacle).
* There is a lack of commercial and financial expertise in LDCs (This obstacle was assessed by DCs as more critical than LDCs: Knowledge-oriented obstacle).
* There is little communication between politicians or legislators and telecommunications operators in restructuring the telecommunications sector in LDCs (Politics-oriented obstacle).
* Some of the conditions attached to financial assistance from international and/or regional funding institutions result in conflicts in LDCs (Politics-oriented obstacle).
* LDCs lack proper planning skill, sufficient information systems and long-term oriented planning and investment (Planning and Implementation-oriented obstacle).
* The profits of foreign telecommunications services providers are not re-invested in LDCs (Economy-oriented obstacle).
* Heavy investment is required for people in rural areas scattered throughout a wide geographical area (Geography-oriented obstacle).

6.3 Additional Observations

Overall, LDCs gave higher scores to most obstacles across categories than DCs did. This fact indicates that LDCs are aware of the variety of existing problems and are concerned about them. Then how could the lower scores of DCs for the same obstacles be understood? Servaes states ".... an outside view of a society's development may be very different from the assessment made by that society of itself" (1991, p. 73). Thus it might be difficult for DCs to share the same level of concerns as LDCs even if they have recognized the negative impacts of those obstacles. Another interpretation would be that DCs have not realized how critical those obstacles are for LDCs.

There were, however, a few issues to which DCs gave higher scores than LDCs, although differences of the assessment were not statistically significant. Firstly, DCs consider that political instability in LDCs discourages foreign investment and leads to widen the gap. Secondly, the continuing monopoly system and accompanying siphoning of telecommunications service revenues for other purposes are also considered to be highly critical. Thirdly, corruption, nepotism and kick-backs-related obstacles got higher scores from DCs. Corruption discourages DCs from coming to LDCs either for assistance or for investment. Although the issue of corruption is very sensitive and is not always openly discussed, it should be noted that the issue was raised in the survey and assessed as quite a critical obstacle, especially by DCs.

There was one obstacle to which DCs gave a significantly higher score than LDCs. DCs strongly expressed that LDCs need to acquire more commercial, financial and market expertise and need to reduce the power of bureaucrats.

6.4 Obstacle Factors

Ten out of twelve categories contain more than one obstacle. A Factor Analysis was carried out for each of the ten categories of obstacles to see if there were clusters among those multiple obstacles. N was 93, which was the total number of responses to the second-round. The results revealed that seven out of the ten categories had a couple of obstacle factors within them. They were: policy and regulation; organization and administration; finance; technology; human resources; knowledge; and politics. A total number of 23 obstacle factors were identified. No factor appeared in categories such as planning and implementation, economy, social systems/culture.

After reviewing how the obstacles were clustered within the 23 resultant factors, following obstacle factor descriptions were generated as presented in Table 4.

Table 4. Obstacle Factor Descriptions

Category	Factor	Description
Policy and Regulation	PRF1	Unchanged policies and regulations in LDCs.
	PRF2	Introduced external policy and regulations that do not necessarily match the special conditions of LDCs.
	PRF3	High tariff in LDCs.

Table 4 (Continued). Obstacle Factor Descriptions

Category	Factor	Description
Policy and Regulation	PRF4	Incomplete regulatory structure in implementing liberalization policy in LDCs.
Organization and Administration	OAF1	Unclear goals of assistance from international and/or regional telecommunications organizations.
	OAF2	Low remuneration for qualified staff in government organizations.
	OAF3	Services provided by bureaucrats not by technocrats.
Finance	FIF1	The small market size and dependency on DCs' resources.
	FIF2	Unsatisfactory official funding from bilateral and multilateral sources.
	FIF3	Too much dependence on international and/or regional funding institutions.
	FIF4	Unsatisfactory conditions for foreign investment.
	FIF5	Inadequate financial resources to the telecommunications sector.
	FIF6	Wrong pricing and poor credit control.
Technology	TEF1	Selling of technology without real technology transfer.
	TEF2	Too many alternative technologies, most of which are designed for DCs' needs.
Human resources	HMF1	Insufficient training assistance.
	HMF2	Corruption and nepotism.
	HMF3	High staff turnover and limited in-country training facilities.
Knowledge	KWF1	Lack of knowledgeable and impartial advice.
	KWF2	Rapid technology change and high cost of obtaining new knowledge.
Politics	POF1	Little communication between politicians or legislators and telecommunications operators.
	POF2	Lack of a holistic view about roles of telecommunications and the resulting low national priority for telecommunications development.

Table 4 (Continued). Obstacle Factor Descriptions

Category	Factor	Description
Politics	POF3	Political instability and politicians' continuing support of monopoly system.

6.5 Similarly and Differently Assessed Obstacle Factors and Categories of Obstacles

Since each obstacle had been assessed, using a scale from 1 (not important/critical) to 7 (very important/critical), in the second round, the mean of the assessed scores of all the obstacles clustered in one obstacle factor was computed for LDCs and DCs respectively. Then an independent t-test between the two means was carried out. Table 5 summarizes to which factor/category of obstacles LDCs and DCs gave a similar assessment and in which factor/category they held a different perspective.

Table 5. Similarly and Differently Assessed Obstacle Factors and Categories of Obstacles

Category	Assessment	
	Not Significant Difference	Significant Difference
Policy and Regulation	**PRF1**: Unchanged policies and regulations in LDCs. **PRF3**: High tariff in LDCs. **PRF4**: Incomplete regulatory structure in implementing liberalization policy in LDCs.	**PRF2**: Introduced external policy and regulations that do not necessarily match special conditions of the LDCs.
Organization and Administration	**OAF1**: Unclear goals of assistance from international and/or regional telecommunications organizations. **OAF3**: Services provided not by technocrats but by bureaucrats.	**OAF2**: Low remuneration for qualified staff in government organizations.
Finance	**FIF4**: Unsatisfactory conditions for foreign investment. **FIF5**: Small financial resources to the telecommunications sector.	**FIF1**: The small market size and dependency on the DCs' resources. **FIF2**: Unsatisfactory official funding from bilateral and multilateral sources. **FIF3**: Dependence on international and/or regional funding institutions. **FIF6**: Wrong pricing and poor credit control.
Technology		**TEF1**: Selling of technology without real technology transfer. **TEF2**: Too many alternative technologies, most of which are designed for DCs' needs.
Human resources	**HMF1**: Insufficient training assistance. **HMF2**: Corruption and nepotism. **HMF3**: High staff turnover and limited in-country training facilities.	
Knowledge	**KWF1**: Lack of knowledgeable and impartial advice.	**KWF2**: Rapid technology change and high cost of obtaining new knowledge.

Table 5 (Continued). Similarly and Differently Assessed Obstacle Factors and Categories of Obstacles

Category	Assessment	
	Not Significant Difference	Significant Difference
Politics	**POF2**: Lack of a holistic view about roles of telecommunications and the resulting low national priority for telecommunications development. **POF3**: Political instability and politicians' continuing support of monopoly system.	**POF1**: Little communication between politicians or legislatures and telecommunications operators.
Others	**CR**: Corruption	**PI**: Planning and Implementation **EO**: Economy **GO**: Geography **SS**: Social System/ Culture

On one hand, considering that both LDCs and DCs have shown similar concerns about approximately half of the obstacle factors and categories of obstacles, there will be opportunities for them to seek common strategies to tackle the problems. Especially in the category of human resources development, LDCs and DCs were consistent in their assessments of the levels of significance of these problems. Thus, there should be harmonized strategies to overcome the problems. On the other hand, it is true that there was a similar number of obstacle factors and categories of obstacles in which the appraisal of LDCs and that of DCs were not in agreement. The problems in the policy and regulation, finance, technology and knowledge categories are not limited to LDCs and are often closely associated with DCs. The underlying reasons for such perceptual differences need to be carefully examined and clarified. Particularly, the fact that all the obstacle factors in the technology category showed different assessments indicates the need to examine, with much caution, how technology-oriented obstacles have hindered telecommunications development. This finding points out the need for further research on technology-oriented problems.

6.6 Rank Order of Similarly and Differently Assessed Obstacle Factors and Categories of Obstacles

Figure 4 presents the obstacle factors and the category that are in the column of Not Significant Difference in Table 5. Each bar for obstacle factor or category consists of the score of LDCs at one end and the score of DCs at the other. Each bar represents the difference of the two scores, nevertheless, the difference is not statistically significant in Figure 4. That is, LDCs and DCs basically agreed with the level of negative impact of these factors and the category of obstacles.

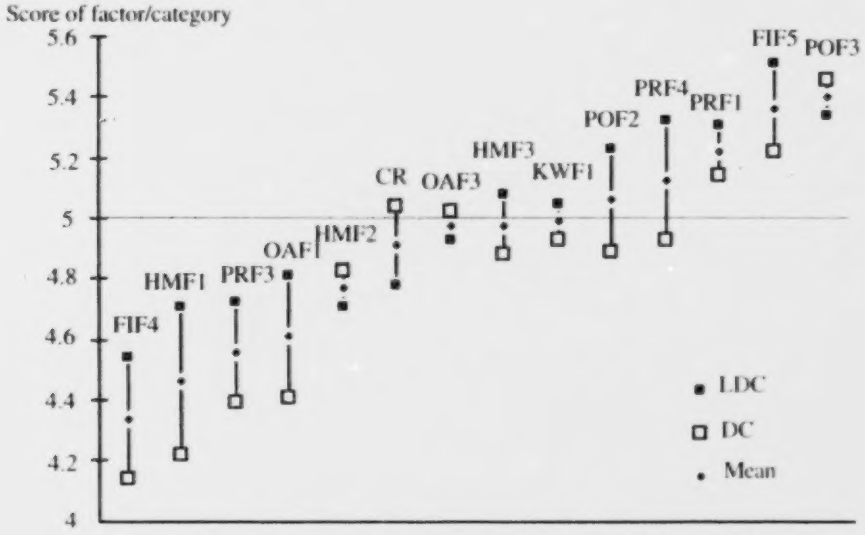

Figure 4. Factors/category assessed similarly by LDCs and DCs.

Suppose that a mean score of 5.0 is set as an adequate threshold to determine if or not an obstacle factor or category is judged as highly critical, five obstacle factors from the right appear to be highly critical. Their depictions are as follows:

POF3. Political instability and politicians' continuing support of monopoly system;

FIF5. Small financial resources to the telecommunications sector;

PRF1. Unchanged policies and regulations in LDCs;

PRF4. Incomplete regulatory structure in implementing liberalization policy in LDCs; and,

POF2. Lack of a holistic view about roles of telecommunications and the resulting low national priority for telecommunications development.

POF2 and POF3 refer to the government and politicians' passive attitude toward the telecommunications development. PRF1 and PRF4 are interrelated in a sense that clearing PRF1 is a minimum requirement and clearing PRF4 is the next step to take. FIF5 is and has been a very serious issue. While none of these issues can be easily resolved, it is important to note that both LDCs and DCs have shared the same level of concern about these factors' negative impacts on telecommunications development.

Figure 5 presents the obstacle factors and categories of obstacles that are in the column of Significant Difference in Table 5. Each bar represents the difference of the two scores, and in Figure 5 the difference is statistically significant. That is, perspectives of LDCs and of DCs regarding the levels of negative impacts of these factors and categories were significantly different.

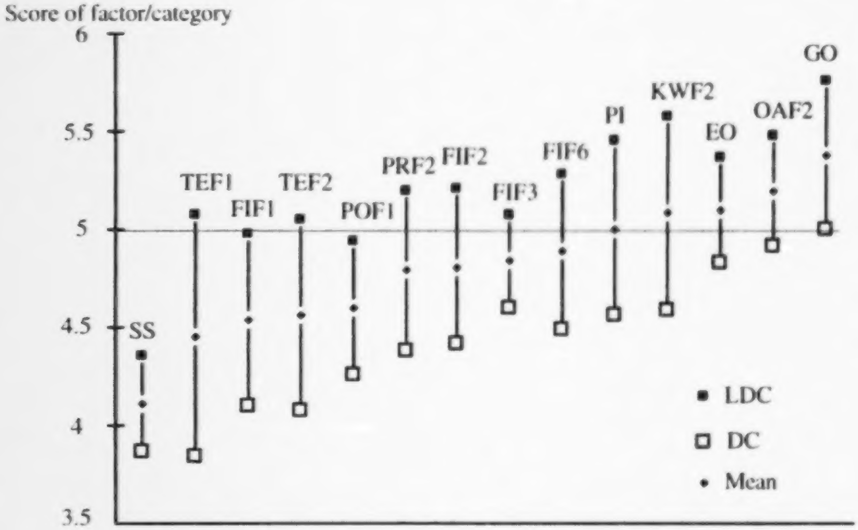

Figure 5. Factors/categories assessed differently by LDCs and DCs.

Again, if a mean score of 5.0 can be set as a threshold to determine if or not an obstacle factor or category is judged as highly critical, two obstacle factors and three categories from the right appear to be highly critical. Their depictions are as follows:

GO. Geography-oriented obstacles;

OAF2. Low remuneration for qualified staff in government organizations;

EO. Economy-oriented obstacles;

KWF2. Rapid technology change and high cost of obtaining new knowledge; and,

PI. Planning and implementation-oriented obstacles.

While GO and EO are external constraints affecting the telecommunications sector, OAF2 and PI reflect the problems often found in the sector itself. KWF2 is also an external constraint in the sense that many of the LDCs have no choice other than adapting to advanced technologies developed in DCs.

One striking difference between Figure 4 and Figure 5 is that in Figure 5 LDCs' assessments on all obstacle factors/categories of obstacles except for POF1 and SS are higher than 5.0, whereas DCs' assessments are lower than 5.0. Thus, Figure 5 clearly shows the significant degree of discrepancy of perspectives existing between LDCs and DCs. Since development of telecommunications in LDCs is a common goal that will satisfy the interests of both LDCs and DCs, the existing misunderstandings about the problems should not be ignored. Before the misunderstandings are further compounded and increasingly aggravated, both LDCs and DCs need to discuss their perceptions of the problems and the strategies to overcome the problems.

7. FUTURE STRATEGIES TO CLOSING THE TELECOMMUNICATIONS DEVELOPMENT GAP

The question in the third-round questionnaire was to solicit feedback on the strategies identified in the second-round survey. The questionnaire requested that the survey participants critically analyze the current and future strategies identified in the second-round survey and modify, enhance or add new insights to them.

In the following section, characteristics of those elaborated strategies will be discussed by paying due attention to which group (i.e. LDCs or DCs) provided the strategy. Whether or not some of those provided strategies are in fact being implemented will also be explored.

7.1 Strategies to Overcoming Policy and Regulation-oriented Obstacle Factors (PRF)

Table 6 summarizes four policy and regulation-oriented obstacle factors (PRFs) and strategies to overcoming those factors.

Table 6. Future Strategies to Overcoming Policy and Regulation-Oriented Obstacle Factors (PRF)

	Future Strategies	
Factor	Suggested by LDCs	Suggested by DCs
PRF1: Unchanged policies and regulations in LDCs.	* International and regional telecommunications organizations (like the ITU) should elaborate and advocate a clear policy for commercialization and liberalization and cooperate with financial institutions/private investors on policy matters. * Hold seminars and/or meetings on privatization.	* Hold international seminars on liberalization policies. * An ITU working group is looking into various regulatory and privatization models and coming up with recommendations. * Follow examples of other countries of similar status.
PRF2[a]: Introduced external policy and regulations that do not necessarily match special conditions of the LDCs.	* Avoid to copy the practices in the developed nations.	* Carry out a survey by a joint group of experts from both DCs and the developing country.
PRF3: High tariff in LDCs.	* None.	* None.
PRF4: Incomplete regulatory structure in implementing liberalization policy in LDCs.	* Mandate an international gateway facility provider and/or a cellular mobile operator to install a certain number of local exchange lines. * Policy makers must ensure that new entrants fulfill their commitments. * The regulatory body should control the public and private companies' operation to ensure a fair competition. * The regulatory body should be involved in the strategic management and investment policy of a new provider and should prevent a monopoly situation. * The regulatory body should encourage as much local capital as possible. * Establish a solid regulatory body with a sound regulatory framework.	* Active participation of LDCs in the two study groups in the development sector of the ITU. * Establish an independent regulatory institution. * Give autonomy to the public telecommunications companies with regard to their budgets, investment, management, buying procedures, contracting of personnel and a tariff policy.

[a] The assessments between LDCs and DCs were significantly different in this factor.

Concerning PRF1, high expectations exist about the role that international organizations, especially the ITU, could play in studying a variety of policy and regulatory models and providing LDCs with recommendations. Although there was no strategy identified for PRF3, the setting of adequate tariff should be included in the above-mentioned models and recommendations. Most suggestions for PRF4 address the establishment of an independent regulatory agency to facilitate the restructuring of the telecommunications sector. Some countries that established a regulatory agency during the past several years are Hong Kong (Ure, 1995a, p. 25), Tanzania (Kiula, 1994, p. 36), the Philippines (Lichauco, 1994, p. 38), Mexico (ITU, 1994a, p. 70) and Colombia (Pisciotta, 1994, p. 30). The structure of the regulatory body and how the regulatory philosophy is implemented may vary from country to country (Pisciotta, 1994, p. 30). It is important to understand, however, that two major roles of the regulator are to establish the rules of the game and to ensure fair competition, fulfillment of operators' obligations and protection of user rights (ITU, 1994a, p. 68; Lichauco, 1994, p. 38). Although the assessments of LDCs and of DCs about PRF2 differ, their suggested strategies point out the necessity to devise policies and regulations specific to a country's needs, whether or not outside experts are used. Malta is one successful example of improving the telecommunications infrastructure with a close partnership with the ITU (Dimech, 1994, p. 32).

7.2 Strategies to Overcoming Planning and Implementation-oriented Obstacles

Table 7 summarizes future strategies to overcoming planning and implementation-oriented obstacles.

Table 7. Future Strategies to Overcoming Planning and Implementation-Oriented Obstacles

Future Strategies	
Suggested by LDCs	Suggested by DCs
* Create an office to implement the installation, operation & maintenance of public telephones in every municipality in the country. * Have both short-term and long-term planning with coordination and continuity between related projects. * Plan by a centralized department rather than by different departments. * Conduct a feasibility study for new projects. * Take account of customer needs and the grade of service in any planning activity. * Ensure that staff is aware of the vast changes in telecommunications. * Shorten the time period between the study and implementation of a project.	* The least cost solution for service delivery and expansion targets based on demand for service should be the *modus operandi*. * Include development of the telecommunications structure as a compulsory element in any aid project. * Bear in mind that long term solutions might not ease short term problems. * Prioritize general management-related goals to improve quality of assistance.

It should be understood that short-term planning is necessary to solve short-term problems and long-term planning is necessary to cope with long-term problems. Also short-term planning must be aligned with long-term planning. In terms of long-term planning, a long-term national commitment to telecommunications development is very important. For example, in Taiwan, the government stressed the development of ten industries and four of them were related to information technology and telecommunications industries. As a result, over the past ten years, the annual output of the telecommunications industry increased by 52.63% and the information industry by 574.66% (Choi, 1992, p. 5). Other examples are found in Botswana, Turkey and the Republic of Korea. They had kept high levels of investment in the telecommunications infrastructure over a decade, and as a result, they had achieved some of the fastest growth rates of teledensity in the world (ITU, 1994a, pp. 84-87). In the case of the Republic of Korea, the strong national consensus of the strategic role of information technology, including telecommunications, was a key factor for its success (Kim, Kim, & Yoon, 1992, p. 1841).

7.3 Strategies to Overcoming Organization and Administration-oriented Obstacle Factors (OAF)

Table 8 summarizes three organization and administration-oriented obstacle factors (OAFs) and strategies to overcoming those factors.

Table 8. Future Strategies to Overcoming Organization and Administration-Oriented Obstacle Factors (OAF)

	Future Strategies	
Factor	Suggested by LDCs	Suggested by DCs
OAF1: Unclear goals of assistance from international and/or regional telecommunications organizations.	* None.	* None.
OAF2[a]: Low remuneration for qualified staff in government organizations.	* None.	* None.
OAF3: Services provided not by technocrats but by bureaucrats.	* Have consultants examine areas such as regulations, laws, financial impact on government, etc.. * Turn the operator into an independent company with complete autonomy, and then establish a good and solid regulatory body.	* The regulatory body has to be set up first and then make an independent company.

[a]The assessments between LDCs and DCs were significantly different in this factor.

With regard to OAF3, one strategy to changing the outdated organizational culture is to turn the monopoly operator into an independent company. Although the two suggested orders of establishing an regulatory body and of turning the government operator into an independent company are contradictory, the point remains that corporatization should be conducted after a good and sound regulatory framework is established with appropriate legislation.

7.4 Strategies to Overcoming Finance-oriented Obstacle Factors (FIF)

Table 9 summarizes six finance-oriented obstacle factors (FIFs) and strategies to overcoming those factors.

Table 9. Future Strategies to Overcoming Finance-Oriented Obstacle Factors (FIF)

	Future Strategies	
Factor	Suggested by LDCs	Suggested by DCs
FIF1[a]: The small market size and dependency on DCs' resources.	* None.	* Start with a BOT operation. * Invite foreign investment and then localize their production by technology transfer. * Establish a common model for convergence regionally and set up a transitional system allowing the countries to have strong collaboration. * The ITU can encourage groupings of countries to create critical mass/risk-spreading for potential investors/suppliers.
FIF2[a]: Unsatisfactory official funding level from bilateral and multilateral sources.	* Using commercial off shore loans.	* Establish a global loan program. * Establish a voluntary organization specialized in telecommunications assistance. * Investment community's more proactive investment.

[a]The assessments between LDCs and DCs were significantly different in this factor.

Table 9 (Continued). Future Strategies to Overcoming Finance-Oriented Obstacle Factors (FIF)

Factor	Future Strategies	
	Suggested by LDCs	Suggested by DCs
FIF3[a]: Too much dependence on international and/or regional funding institutions.	* None.	* None.
FIF4: Unsatisfactory conditions for foreign investment.	* None.	* None.
FIF5: Inadequate financial resources to the telecommunications sector.	* Restructure the sector aiming at involvement of a private sector and foreign investors and aiming at enabling the sector to more adequately adapt to the ever changing economic environment. * Create a private, domestic telecommunication financing institution to mobilize funds from local institutional investors.	* Mandate the new service provider to serve both urban and rural areas. * Have new service providers to put part of their revenues in a Development Fund.
FIF6[a]: Wrong pricing and poor credit control.	* Readjust tariffs towards cost.	* None.

[a]The assessments between LDCs and DCs were significantly different in this factor.

Relating to the suggestions for FIF2, in 1995, the ITU in fact inaugurated a private sector driven multinational and development funding organization, called WorldTel, which focused exclusively on the development of telecommunications and information technology in the least developed countries. WorldTel will provide client LDCs with direct equity investment raised from private financial investors in the world and coordinate project finance from debt and/or equity coming from governments, telecommunications operators and manufacturers. It will also help client countries improve their policies and management practices (ITU, 1995, pp. 1-4). This new initiative reflects the shift from public sector-driven development to private sector-driven development. The establishment of a similar financing institution within a country is proposed as one solution to FIF5. Considering that adequate telecommunications infrastructure and services enhance the productivity and efficiency of many other sectors such as transportation, tourism, health and education, the feasibility of this idea may be worth examining further.

The suggestions from DCs for FIF5 address the requirement of new service providers coming into the market. In the Philippines, President Ramos issued two executive mandates and one of them required that any service provider operating in a lucrative area should provide less profitable areas with a certain number of local lines (Lichauco, 1994, p. 38). Regarding FIF1, Thailand may be a representative example to show how effectively a developing country can utilize a BTO (Build-Transfer-Operate) scheme. The strategy has brought in about US$10 billion of private capital to telecommunications infrastructure improvement and it has especially contributed to the mobile telecommunications sector (Harrington, 1995, pp. 94-95). The above mentioned WorldTel will also make the best use of the BOT (Build-Operate-Transfer) scheme (Ras-Work, 1995).

7.5 Strategies to Overcoming Technology-oriented Obstacle Factors (TEF)

Table 10 summarizes two technology-oriented obstacle factors (TEFs) and strategies to overcoming those factors.

Table 10. Future Strategies to Overcoming Technology-Oriented Obstacle Factors (TEF)

Factor	Future Strategies	
	Suggested by LDCs	Suggested by DCs
TEF1[a]: Selling of technology without real knowledge transfer.	* Big international companies awarded big contracts are contractually committed to spend a certain percentage of the contract value in establishing national companies for technology transfer. * Technology transfer should help LDCs acquire the ability to build and manufacture their own equipment.	* Opposition.
TEF2[a]: Too many alternative technologies, most of which are designed for DCs' needs.	* The community's engagement by way of organized sectors such as unions and associations is the best way to find the most adequate solutions both in technical and economic terms.	* Opposition.

[a] The assessments between LDCs and DCs were significantly different in this factor.

Suggested strategies were split into two opposite ones. On one hand, LDCs want to build their own manufacturing capability to cope with technology-oriented obstacles and expect international companies to play some key role for this purpose. One of the strategies that have accelerated telecommunications development in Indonesia is the promotion of local industries. Indonesia is about to export telecommunications products (Parapak, 1994, pp. 40-41). On the other hand, there is pessimism about the possibility of manufacturing telecommunications equipment in LDCs. It was pointed out that many DCs do not manufacture telecommunications equipment. Even in the Republic of Korea where their own switching technology was successfully developed and manufactured, the reality is that "It may well be the case that even South Korea can buy cheaper switches than the ones manufactured at home from highly competitive international suppliers (Kim, Kim, & Yoon, 1992, p. 1841). Thus, strategies to these two factors are mixed. Considering that both TEF1 and TEF2 were assessed differently by LDCs and DCs and no agreed strategy was found to this problem, it appears that technology-related, especially technology transfer-related obstacles and possible solutions will require more in depth scrutiny.

7.6 Strategies to Overcoming Human Resources-oriented Obstacle Factors (HMF)

Table 11 summarizes three human resources-oriented obstacle factors (HMFs) and strategies to overcoming those factors.

Table 11. Future Strategies to Overcoming Human Resources-Oriented Obstacle Factors (HMF)

Factor	Future Strategies	
	Suggested by LDCs	Suggested by DCs
HMF1: Insufficient training assistance.	* Develop own institutional development programs. * Conduct an intense human resources training program at both technological and managerial levels.	* Train experts and staff not only in the field of technology but also in the aspects of policy and management in assistance with international organizations such as the ITU, the World Bank, etc.. * Emphasize training in more specialized technical & professional as well as executive & management fields.
HMF2: Corruption and nepotism.	* None	* None.

Table 11 (Continued). Future Strategies to Overcoming Human Resources-Oriented Obstacle Factors (HMF)

Factor	Future Strategies	
	Suggested by LDCs	Suggested by DCs
HMF3: High staff turnover and limited in-country training facilities.	* Bond trainees to return after completion of training overseas. * With the help of the ITU, an institutional development program was upgraded and a Telecommunications Training Center was established.	* None.

One common feature in the strategies to HMF1 indicates the necessity to train people not only in the technical field but also in professional, management and policy fields.

7.7 Strategies to Overcoming Knowledge-oriented Obstacle Factors (KWF)

Table 12 summarizes two knowledge-oriented obstacle factors (KWFs) and strategies to overcoming those factors.

Table 12. Future Strategies to Overcoming Knowledge-Oriented Obstacle Factors (KWF)

Factor	Future Strategies	
	Suggested by LDCs	Suggested by DCs
KWF1: Lack of knowledgeable and impartial advice.	* None.	* The ITU, World Bank, OECD etc. could usefully prepare a number of case studies regarding restructuring of the telecommunication sector. The case studies could be used as a basis for showing and comparing changes through several simple parameters on a spreadsheet.
KWF2[a]: Rapid technology change and high cost of obtaining new knowledge.	* None.	* None.

[a]The assessments between LDCs and DCs were significantly different in this factor.

The DCs' strategy to KWF1 is similar to the strategies suggested in PRF1. It should be noted, however, that LDCs did not propose any strategy. The obstacles composing KWF1 seem to reflect LDCs' displeasure about the conduct of foreign companies and assistance from DCs as well as international and/or regional organizations. Since KWF1 is the sixth critical factor in Figure 4, the underlying problems of this factor need to be examined carefully. In addition, since KWF2 is another critical factor, strategies to KWF2 should be sought in future research.

7.8 Strategies to Overcoming Politics-oriented Obstacle Factors (POF)

Table 13 summarizes three politics-oriented obstacle factors (POFs) and strategies to overcoming those factors.

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Table 13. Future Strategies to Overcoming Politics-Oriented Obstacle Factors (POF)

Factor	Future Strategies	
	Suggested by LDCs	Suggested by DCs
POF1[a]: Little communication between politicians or legislators and telecommunications operators.	* None.	* None.
POF2: Lack of a holistic view about the role of telecommunications and the resulting low national priority for telecommunications development.	* Invite Ministers of Communication to attend conferences on telecommunications to learn about the issues involved. * Provide Ministers with information briefings on telecommunications issues.	* Let politicians know the importance of telecommunications by showing the effect of telecommunications infrastructure on economic growth with examples in DCs. * The ITU should sponsor a one week seminar attended by ministers of communications to convince them of the benefits of telecommunication development by reviewing success stories.
POF3: Political instability and politicians' continuing support of the monopoly system.	* Sensitize politicians to private investment as the only means to enhance development of telecommunication sector in LDCs.	* Sensitize key officials and other high level decision makers who will be around for a long time rather than politicians who are in office for a limited term. * More emphasis should be placed on documenting the alternative costs of current politics/priorities and policies/regulations.

[a]The assessments between LDCs and DCs were significantly different in this factor.

Regarding POF2 and POF3, all of the suggested strategies indicate the necessity of further efforts to convince politicians as well as key officials of the significant positive impacts of telecommunications development on the country. One suggestion is to show successful cases from other countries. Another is to show the potential cost of continuing underdevelopment in the country by maintaining the status quo. Considering that the underdevelopment and/or the present slow development of telecommunications in many LDCs will not evidently bring anything beneficial to those countries, a variety of innovative approaches for changing the thinking of key people should be pursued by countries and by multilateral organizations.

7.9 Strategies to Overcoming Geography-oriented Obstacle

Table 14 summarizes suggested strategies to overcoming the geography-oriented obstacle.

Table 14. Future Strategies to Overcoming Geography-Oriented Obstacle

Future Strategies	
Suggested by LDCs	Suggested by DCs
* Extend mobile satellite services, fixed cellular networks and wireless technologies to reach rural subscribers. * Satellites have a major role to play in providing communications to scattered populations in remote rural areas.	* Increase the use of small, hand-portable mobile earth stations to end the isolation of remote and rural areas in LDCs. * Satellites in particular have a major role to play in providing telecommunications in LDCs due to their ubiquitous coverage and ability to provide instantaneous communication links without the need for substantial investment in terrestrial infrastructure.

Table 14 (Continued). Future Strategies to Overcoming Geography-Oriented Obstacle

Future Strategies	
Suggested by LDCs	Suggested by DCs
	* Develop semi-fixed analog mobile phone cells placed in communities without telecommunications, complete with cheap handsets and VSAT links to regional hubs. * Conduct pilot projects in selected countries to demonstrate an end to end wireless system (i.e., radio in local loop/satellite communications).

Most of the strategies address further implementation of wireless technologies to overcome geographical problems and to avoid the substantial investment in terrestrial infrastructure. In fact, the growth of mobile communication is dramatic in several LDCs. Over two years from 1991 to 1993, for instance, the number of mobile subscribers increased more than nine times in China and Thailand, more than four times in Malaysia and more than two times in Indonesia and the Philippines (World Telecom, 1995, p. 66). Indonesia, composed of 17,508 islands, has used the PALAPA satellite for many years. In Africa, the feasibility of the Regional African Satellite Communication System (RASCOM) project was studied by participating African countries and the ITU. The project is now moving toward its implementation stage (ITU, 1994b, p. 12). Wireless technology is clearly the key solution to the geographical obstacle.

8. CONTRIBUTIONS OF THE STUDY

A major contribution of the study is the extension of our knowledge in three important areas: the nature of the underdevelopment of telecommunications in LDCs; the obstacles that have slowed the expected advancement of telecommunications; and, possible future strategies that may be effective in overcoming the obstacles. The study investigated each of these issues comprehensively by providing a more holistic picture of each issue rather than focusing on part or a single facet of the problem. The study achieved this comprehensive analysis by incorporating a variety of viewpoints from approximately 50 countries and by elaborating those inputs in the three-round survey.

The study generated an analytical framework in understanding the problem of the telecommunications development gap (see Figure 3). The framework was derived from the survey participants' assessment of the 12 dimensions of the gap. The figure shows that the problem of the telecommunications development gap has both a quantitative and qualitative nature. It further shows that the qualitative nature of the problem is composed of impediment and consequence. Factor 3, the impediment of the gap, was found to be most critical. Thus, the crucial nature of factor 3 was emphasized.

These findings point out the need to clarify which factor of the telecommunications development gap is discussed or examined in a study or in a development project. In addition, they indicate that the most critical factor, the impediment of the gap (factor 3), must not be overlooked in any case.

As the label "the impediment of the gap" shows, the factor addresses many of the difficulties that LDCs have confronted in trying to narrow the gap. The study regarded these difficulties as obstacles to telecommunications development. Firstly, the study identified a total of 127 obstacles. These 127 obstacles were consolidated from initially identified 398 obstacles. Thus, the study identified the full range of 127 obstacles to advancing telecommunications in LDCs. No research had before examined the range of obstacles or provided a comprehensive framework of obstacles to narrow the telecommunications development gap.

The present study used Bernt and Weiss' (1993) four categories, regulatory, economic, organizational and technical as a framework to identify all the possible obstacles. Considering the importance of the human aspects of the problem, the researcher added knowledge and human resources as additional categories to the framework. This framework was used in the first-round survey to identify all the possible obstacles. After the responses, the researcher examined the nature of all the obstacles and found that some of the obstacles did not categorize well in the framework. At last, four additional categories were developed. The resulting comprehensive framework of obstacles consisting of 12 categories is presented in Figure 6. This framework categorizes the gamut of obstacles inherent to telecommunications development in LDCs, and thus, is one of the important contributions of the study.

If the number of obstacles in a category is regarded as one indicator of the relative importance of the category, we can see that policy and regulation, finance and politics are the most critical issues. No past research had comprehensively categorized the variety of obstacles or examined the relative significance of each category. A better understanding of the basic nature of the problem is most certainly an important contribution of this research.

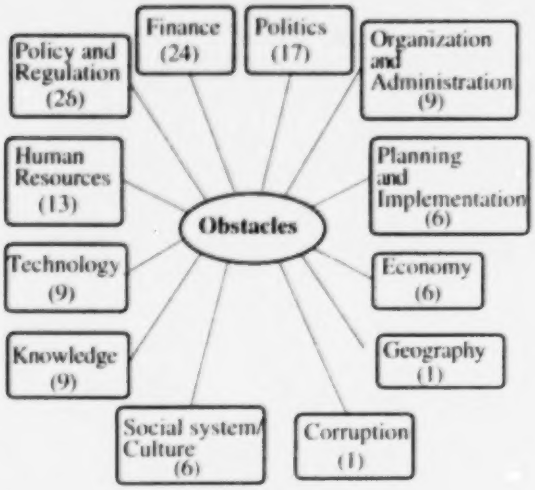

Figure 6. Twelve categories of the 127 obstacles. Note. The value in each category represents the number of identified obstacles in the category.

The study further analyzed each of the 12 categories and identified more than one obstacle factor in seven of the twelve categories. This means that each of the seven categories is composed of sub-elements or different types of problems. The study analyzed the assessment of LDCs and DCs about the degree of seriousness of the individual obstacles, categories of the obstacles and obstacle factors. It found both agreement and disagreement between LDCs and DCs. Very little had been earlier discovered or understood about how LDCs and DCs looked differently at the problem of telecommunications underdevelopment in LDCs.

These findings have important implications for those considering strategies to overcome these obstacles. From a harmonized perspective, there will be opportunities for LDCs and DCs to seek common strategies to tackle the individual obstacles, categories of the obstacles and obstacle factors in which both LDCs and DCs showed similar concerns. Especially in the category of human resources development, LDCs and DCs were completely consistent in their assessments of the levels of significance of these problems. Thus, there should be harmonized strategies to overcome the problems.

From a less harmonized perspective, LDCs and DCs were not in agreement in a similar number of the individual obstacles, categories of the obstacles and obstacle factors. The problems in policy and regulation, finance, technology and knowledge categories in LDCs are not limited to LDCs and are often closely associated with DCs. While the study contributed the identification, the underlying reasons for such perceptual differences need to be carefully examined and clarified. Since development of telecommunications in LDCs is a common goal that will satisfy the interests of both LDCs and DCs, the existing misunderstandings about the problems should not be ignored. Before the misunderstandings are further compounded and increasingly aggravated, both LDCs and DCs need to discuss their perceptions of the problems and the strategies to overcome the problems. Particularly, the fact that all obstacle factors in the technology category showed different assessments indicates the need to examine, with much caution, how technology-oriented obstacles have hindered telecommunications development. This finding points out the necessity for future research on this issue.

Another contribution was the identification of a number of strategies to overcome many of the obstacle factors. Given that one obstacle factor consists of a few individual obstacles, the suggested strategy to a particular obstacle factor can be a strategy applicable to multiple obstacles. It is true that many of the strategies were narrow and would need to be adjusted on a country-by-country basis, nevertheless, it was found that some of those strategies had already been implemented in some countries. This fact implies that the other identified strategies also have a potential to work well to solve other problems. The study has provided a basis for more extensive elaboration of strategies.

One potential contribution of the study was the structure and process of the three-round survey that was developed as a research method. Throughout the three rounds, the focus of the study shifted from clarifying the nature of the problem, to identifying obstacles, and to examining strategies to overcome the obstacles. This process-oriented approach will be useful for exploratory studies in which issues are elaborated extensively without the use of hypothesis testing. It provides an effective way to get an overall sense of a problem and can provide information for studies focused on specific and complex problems.

In summary, the study contributed considerably toward establishing a framework for diagnosing the underdevelopment of telecommunications in LDCs and for prescribing future strategies for reducing the telecommunications development gap. In addition, the study also required the design of a useful research method that could be applied to other studies and pointed out needs for future research in specific areas.

9. IMPLICATIONS OF THE STUDY

From a practical point of view, the study is likely to have significant importance toward determining future actions in narrowing the telecommunications development gap. First, whenever people concerned initiate a telecommunications development project, the distinct three factors of the telecommunications development gap help them identify targeted objectives of the project. That is, at the outset of the project, they can examine whether they will try to improve the quantitative nature of the gap (factor 1), or whether they will attempt to solve qualitative aspect of the gap (factors 2 and 3), and whether they aim at overcoming the impediments of the gap (factor 3). They can focus their investment and their endeavors on the objectives, and as a result, can implement the project more effectively. It should be noted that the most critical factor, the impediment of the gap (factor 3), must not be overlooked in any case. By making the factors of the gap explicit, the overall efficiency of the telecommunications development projects in LDCs is expected to increase.

Secondly, it is important to understand what hindrances exist for solving any kind of problem. The same holds true in narrowing the telecommunications development gap. After a targeted factor of the gap is identified, potential obstacles to efforts should be carefully examined by the people and the organizations concerned. The framework with 12 categories of obstacle and 23 obstacle factors developed in the study is of importance as a guiding tool to investigate the potential obstacles in a particular case. After certain obstacles are identified, they need to be prioritized in accordance with the levels of their negative impacts. Through this process, it will be clearer which obstacles need to be eliminated and in what order.

Thirdly, the current study presents a number of suggested future strategies for overcoming many obstacles. It was found that some of the strategies had already been implemented in some countries. Thus, in considering strategies for eliminating the obstacles identified and prioritized above, some of the suggested strategies in the study can serve as a basis for developing appropriate strategies in a particular case.

Identifying the objective of an effort, locating potential obstacles and deciding on strategies for solving the obstacles are the basic steps to solving problems effectively. In this sense, the findings of the study have significant implications for achieving more efficient telecommunications development in LDCs.

At the same time, the study clearly showed a significant degree of discrepancy of perspectives existing between LDCs and DCs. Since the development of telecommunications in LDCs is a common goal that will satisfy the interests of both LDCs and DCs, the existing misunderstandings about the problems should not be ignored. Before the misunderstandings are further compounded and increasingly aggravated, both LDCs and DCs need to discuss their perceptions of the problems and the strategies to be taken to overcome the problems.

Jamieson (1991) points out:

> .... new awareness of the extent to which all perception is culture-bound and selective and all knowledge is socially produced, imperfect, and incomplete is producing deeper understanding of the idea that there are many ways of construing reality, none of them perfect. As we now realize the problematic nature of our own beliefs and values, we are learning to appreciate the potential merit of perspectives other than our own. (P. 29)

Both LDCs and DCs need to regard overall telecommunications development in the world as their joint cooperative project and to develop the most effective strategies to achieve the goal by listening and more fully understanding each other.

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NOTES:

Understanding The Impact of Network-Based Currencies

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Abstract

As an information technology-enabled innovation, the consequences of the rapid diffusion of electronic money to Asia are far from clear. Following a brief map of the evolutionary path of money, our paper views the strategic interests of the actors in electronic commerce, applies multiple scenario technique to reveal the likely impacts, and closes by evaluating the consequences for network operators and other stakeholders.

Introduction

During the 1996 Olympics Games in Atlanta, banks tested one form of "electronic money" by giving each athlete a disposable smart card programmed as an electronic purse, to be used for purchases in the Games area. In New York City, Citibank and Chase Manhattan recently announced re-loadable, stored value cards to be used for retail transactions [1]. This trend toward electronic retail commerce is diffusing rapidly to Asia: the Singapore National Computer Board is field testing a new national infrastructure designed to support global electronic commerce; HongKong banks have more than 200,000 smart card-based electronic purses in circulation; as Visa tests its Secure Electronic Transactions protocol in Japan, Singapore, and Taiwan. Meanwhile, a Kentucky-based bank offers virtually every retail service on the Internet [2]. The contrast raises strategic issues for Asian enterprises: how can they access new opportunities created by electronic commerce, and what decisions and actions will lead to sustainable competitive advantage in this emerging arena?

The trend toward conducting retail transactions through electronic media embraces both smart card technology and the growing commercial use of the Internet. The popularity of this public network ballooned only after colorful graphics, audio/video capabilities, and "point and click" navigation replaced UNIX commands. With the arrival of adequate transaction security software, the Internet became a global market, with a wide variety of goods and services now only a mouse click from its many users. Banks are exploring technology-based global services and alliances to exploit these new opportunities. Because these alter the nature of money, they may lead to new technical and legal standards, awkward governance issues, and changes in the structure of service industries linked to public networks.

The Evolution of Money

> "Money, Money, Money..
> - it's a rich man's world"
> Abba

Barter was an effective institutional solution to the problem of exchanging an excess of one commodity (e.g., your own labour) to fill a shortage of another (rice or fish), and improved the efficiency of local economies. However, barter markets are inherently inefficient, especially for goods which cannot be stored over time.

Cash solves our problem of storing value over time, and by enabling price comparisons, reduces costs for negotiating transactions. Portable and largely anonymous, cash is convenient, yet its owners are vulnerable to loss, theft, and damage. Cash has drawbacks for other actors: it costs billions to manually count, store, move, and protect printed cash, while the war against counterfeiting, necessary to stabilize its value, escalates with each advance in modern reprographics technology.

Checks are essentially a personal promise of cash, while **Commercial instruments**, with terms and conditions of payment tailored to fit specific needs, represent the institutional evolution of the check. A letter of credit, for example, authorizes a bank to pay a previously negotiated amount to a seller on behalf of a buyer upon the satisfaction of specific terms and conditions, normally associated with delivery [3]. The intended effect of most commercial instruments is to mitigate risk, and hence reduce the transaction costs, for all parties.

Credit card transactions generate a promise by the card service operator (e.g., Visa) to pay the merchant, and obligate the card owner to repay the operator. As a substitute for cash, cards reduce the owner's risk of loss, and as a substitute for checks, they reduce a merchant's cost for collections. Credit card operators help merchants verify cards and assume some responsibility for monitoring fraud, thus reducing liability for both the card holder and merchant [4]. According to Scott Cook of Intuit, with few changes in the system, the standard credit card is a secure and reliable medium for payment over a network [5].

Stored-value cards, which also contain a small magnetic memory, have been in widespread use for more than a decade as a convenient exchange medium for fairly small transactions such as telephone tolls and public transport fees. Because stored-value card service operators are paid in advance for services which will be delivered only in the future, they earn significant revenues by investing the resulting "float" in the money markets. Similar in dimensions (but not format) to credit cards, a proprietary stored value card is less bulky than coins, eliminates the need to make change, and generates no records to link card owners with their transactions. However, widespread use necessitates a reader at each point of sale, and outlets where cards can be obtained. Also, despite initiatives to increase security (such as the Oscard), the underlying technology is highly vulnerable to counterfeiting and duplication, which inhibits applications for larger transactions [6].

Smart cards are more expensive than the earlier card technologies, because they contain a single-chip microprocessor with onboard memory which can be access-protected. Downward-compatible with credit cards, and providing a secure interface to ATM cash dispensers, they will rapidly displace credit card and stored-value card technologies. To use a smart card as an electronic purse, its owner must be able to transfer in funds (as with a stored-value card), then interact with recipients, who can extract the correct amount of funds from this card, attach their own account number, and forward this to a bank to receive credit. Smart card processors provide sufficient security to allow their use for high-value transactions, although users must enter a PIN during payment. Widely used in Europe for small transactions, smart cards linked to DTMF transceivers can access ATM and telephone networks, while the CAFE field trials take the infrared path to secure transactions [7].

Electronic Payments requires "using networks to conduct business transactions with one another electronically" [8]. A payer moves funds to the recipient's account, and both receive verification of the transfer. Although large institutions have used electronic funds transfers for decades, for a variety of applications ranging from payroll to inter bank transfers, credit cards are still the most common payment method on networks. This is because personal use has been inhibited by limited network access, poor security, and clumsy interfaces. However, these barriers are now falling with the diffusion of the World Wide Web and new secure transaction protocols suitable for use on public networks (e.g., STT, SET, and SEPP). Emerging processes for network-based payment will allow personal computer users to obtain money from a bank, store it or transfer it to a smart card, and safely send funds to a recipient (such as a mail-order house, a mortgage company, or data service), who can then use inflows of electronic money to cover their business expenses, or convert it to other forms of cash. These new systems include electronic checking services and digital cash.

Digital Cash is a specific form of electronic money, and now appears in a variety of competing forms. The key differences among these forms lie in the capacity to conduct a transaction off-line (without the presence of the buyer or on-line links to a bank), and whether or not the e-money leaves a trail of information to identify the original purchaser with its use as it flows through the economy [9]. As Figure 1 reveals, true digital cash is both off-line and anonymous, distinguishing it from all other forms of money.

Figure 1: The Features of Money

		Presence*	
		YES: on-line	NO: off-line
Anonymity	*YES*	Real Money Bearer Security **Stored-Value Card**	**Digital Cash**
	NO	Barter Bank Check Credit Card Debit Card **Smart Card**	Letter-of-Credit Digital Bond E-Coupons Digital Check

**required for reasonably secure transactions*

Analysis: The shift to e-money is strategic because it solves time and space problems, while its digital cash variant is significant chiefly because it also enables protecting the anonymity of participants to transactions. Today, it is quite feasible to design a secure payment system to prevent duplicating large amounts stored in a computer or smart card and ensure payment to sellers, while masking the identity of buyers. Network-based e-money thus appears ideally suited to global commerce [10].

The Actors and their Interests

Interactions between these new capabilities and the global reach of public data networks may revolutionize retail financial services and information services industries. It could also pose serious challenges to government authorities. To understand the long-term effects which electronic money may have, it is first necessary to examine the interests of the main parties involved in the trend toward electronic commerce: buyers, merchants, banks, network operators, technology suppliers, and governments.

Parties to transactions are the driving force for the diffusion of electronic cash. Their needs for security, ease-of-use, authentication, low costs, and anonymity vary with the type of transaction: obviously, security and authentication are critical for high-value items, while small convenience purchases (e.g., on-line news) demand very low costs and easy execution, and other transactions may require privacy. Consumers may be more sensitive to convenience, security, and privacy, while merchants will probably be concerned with added fixed costs, difficulties in managing their interfaces with multiple payment channels, and liability issues associated with returns and frauds.

Network operators range from America OnLine and Prodigy to special-purpose networks enabling EDI or credit-card transactions. Most commercial services now run on value-added private networks or use dedicated lines, while an Internet-based service offers lower cost per transaction. For current operators of value-added commercial services, interactions between emerging security protocols and network-based electronic money technologies represent a serious potential threat.

Fiduciaries are entrusted with the transfer of payment among the parties to the transactions. They include varying types:

Figure 2: Emerging Digital Fiduciaries

Banks and card operators:	
First Virtual	Confirms all transactions
Cybercash	Download to PC "purse"
Digicash (Mark Twain Bank)	64-bit codes representing cash
NetBank ®	Sells Netcash: fixed amounts
CitiBank	Smart Card-based "purse"
Electronic Check systems	
CheckFree	Digitally signed, processed by Automated Clearing House like ordinary paper check.
NetCheque	
NetChex	

Government agencies do have legitimate interests in governing money flows within a national economy, and very large transactions (especially across national borders) tend to attract unwanted attention from law enforcement and tax authorities. Various other agencies (e.g., monetary authorities) intervene by limiting consumer credit or regulating transborder currency flows. Central banks worry (perhaps uneccessarily) about loss of revenue from the float associated with seignorage). Policy issues now under review include controls over the right to issue electronic money, reserve requirements for issuers, the definition of money from an economic polcy perspective, and interest and tax payments on value held on the network [11].

Suppliers of network hardware and software see the rapid evolution of electronic commerce as a threat, and an opportunity. One critical success factor is the secure transaction standard: proposals include the Visa- and Microsoft-backed Secure Transactions Technology (STT), or the Secure Electronic Payment Protocol (SEPP) standard proposed by MasterCard, GTE, IBM, Netscape, and CyberCash. While both standards were viable from a technical perspective, these suppliers and fiduciaries soon realized only one was likely to attract the necessary critical mass of merchants, so they joined in the Secure Electronic Transaction (SET) standard, which now looks sure to win.

Another key factor is transaction security. Industry leaders such as Quicken, Germany's SAP, and Sterling Software already embrace the convergence between EDI and the Internet, but skeptics see the pace of our security expertise growing no faster than the sophistication of electronic thieves. According to them, the electronic medium will never gain our full confidence, and "traditional" currencies will prevail [12]. This seems a familiar echo to those who remember the early days of bank ATMs.

Changing Structural Forces:

The banking industry, which is highly dependent on information technology, commands a central role in the commercial world. Learning from their early experiences with home banking using dialup access to proprietary networks, banks see a need for secure and convenient systems for use on public networks [13]. Analysts forecast rapid growth in the use of applications involving smart cards and Internet transactions. Soon, any networked computer could be an automatic teller machine, from which consumers can download the electronic equivalent of cash in the privacy of their homes, hotel rooms, or (with wireless links) even rental cars. Customers can perform routine personal banking -opening accounts, making deposits and securing overdrafts, loans or guarantees- on-line. Initial trials show promise. One leading survey on global electronic commerce and payments shows annual growth at 16 percent, with projected flows of US $800 billion by the turn of the century [14]. However, such growth will require links between fiduciaries and merchants, which will happen only if they can agree on technical and business standards.

At least 100 international banks have Internet web sites. While many local banks have an Internet presence (in Singapore, DBS, OCBC, OUB, and UOB have sites providing information on their banks, products and services, while smaller banks are set to follow suit), US banks lead in the actual delivery of interactive services to their customers.

Tiny Kentucky-based Security First Network Bank (SFNB), a pioneer in the Internet banking arena, typifies the dramatic implications of public network access to banking. SFNB not only offers its customers a vast array of on-line services, but actually cut its costs, mainly by reducing its operating expenses and avoiding investment in physical infrastructure. While the firm has only one office, this has not reduced its ability to reach out to a widespread customer base, and promise excellent service. Such developments surface new issues that will soon be of concern to managers and regulators of the banking industry [15].

SFNB illustrates these themes. The world's first insured bank to operate on the Internet [16], SFNB provides services similar to a "brick and mortar" bank, plus the added convenience of online banking. Its first Internet banking transaction was the SFNB donation to the Red Cross on October 18, 1995. Since then, its virtual doors have been open 24 hours a day, 7 days a week [17].

Retail banks may choose from two competing models to offer electronic banking services to customers. The first model is computer-based home banking, which requires a personal finance software package (such as Quicken or Microsoft Money) installed on the customer's computer. The customer then uses this system to link to the bank. A second model is Internet banking, in which all software to support on-line banking resides in the bank's computer. A customer needs only access to an Internet-ready personal computer (e.g., with modem and browser) to conduct banking transactions. This model allows the customer to avoid complex tasks -software purchase and installation, data storage on the local computer, data backup, and upgrades to new versions- that have nothing to do with their banking needs. Because all transactions initiated over the global Internet infrastructure actually take place on SFNB's server, they are less expensive and potentially more reliable. Also, banking transactions are now possible from virtually anywhere within reach of the Web.

Internet banking fees compare very favorably with traditional services, raising a question as to how SNFB generates profits. One answer is that SFNB's business model is more efficient than traditional banking models. SNFB portrays its customer coverage as a giant "footprint" spanning the nation through the Internet. However, its only physical infrastructure is the "control hub" for Internet operations, located in and controlled from Pineville, Kentucky. To achieve similar reach, a "bricks and mortar" bank like Citicorp would require perhaps 1000 retail branches, staffed by 10,000 full time employees. Given the low cost of Internet access services, and total annual costs for each bank employee approaching US$ 50,000, the potential for savings are huge. Manpower costs are but one component of overall operating costs, which include overheads such as office rents building maintenance, and security.

SFNB provides the usual banking transactions including opening and operating an account, at no fee. Other products on offer currently include money market accounts and certificates of deposit. Subject to regulatory approval, SFNB also hopes to offer security brokerage, insurance, loans, and other financial services. While the firm intends to generate revenue from these services, it anticipates a fee structure much lower than competitive norms. Its future product plans include credit cards, commercial accounts, and an integrated "net worth solution" service encompassing all financial assets and needs on one screen. In effect, this is a '90s rollout of the Merrill Lynch Cash Management Account of the '80s.

Network operators and banks address security at several levels and points of interaction among the Bank and its customers over the Internet. Critical issues are: (1) end-to-end transaction integrity across the Internet, and (2) protecting business processes against intrusion. As a precaution, SFNB regulates money outflow (as for withdrawal limits for ATM transactions), with limits tailored to customer needs. SFNB research shows that customers with externally accessible passwords and account numbers create most vulnerability.

SFNB combines several technologies to ensure the integrity and confidentiality of online transactions. Netscape's Secure Sockets Layer (SSL) secures all data flow channels between browsers and the bank server. SSL message integrity ensures that data cannot be altered en route, and allows transfer of digitally signed certificates for authentication procedures [18]. At the network level, business processes are protected by a barrier of "filtering routers" and "firewalls" between the external Internet and the internal bank network. A filtering router verifies the source and destination of each network packet, then determines whether or not to let the packet in. Packets which are not directed at a specific, available service are denied access. The firewall shields the customer service network from Internet code and messages. Traffic is addressed to the firewall, which routes only e-mail to the customer service environment. Traffic through the firewall enters a filtering router-like proxy process which verifies the source and destination of each packet. The bank monitors security carefully, and provides FDIC insurance on accounts (normally up to $100,000), so customers aren't worried.

Although network-based competition may erode the value of branch networks, established banks may be able to retain the residual value of their knowledge and expertise, and use these assets to retain their customer base. If so, these banks may continue to dominate specific segments of retail markets, even if Internet banking becomes the dominant model in the future. However, it is equally likely that the structure of the banking industry, the firm's pattern of interaction with its customers, and the critical measures for success will change dramatically [19].

The Future of Network Money

Scenario planning is useful for exploring interactions among current choices and the future environments in which those choices will have consequences. The technique generates likely contexts in which we can develop and evaluate plans. SRI International adapted the technique from its military origins to corporate planning in the 1970s [20]. Current users include transnational firms operating in turbulent contexts, such as oil companies, and governments such as Singapore.

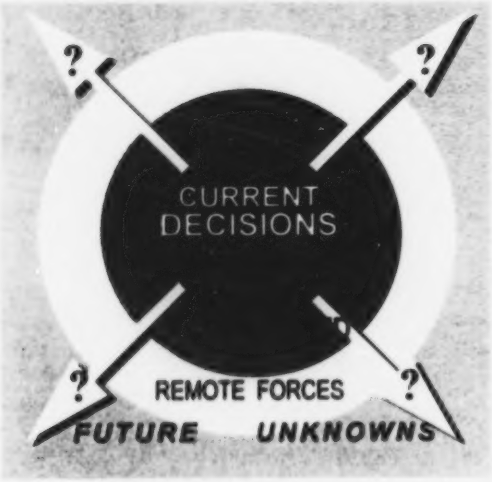
Forecasting is not very useful when the future is likely to be determined by trends that are not simply extrapolations of the present, and events for which there is no historical precedent [21]. A scenario is "A hypothetical sequence of events constructed for the purpose of focusing attention on causal processes and decision points [22]." Each scenario normally consists of a logically coherent description of fundamentally different futures, which explains the interactions between key elements from the present to the end point of the scenario. Thus, scenario planning forces us to make our assumptions about the future explicit. Used to identify major opportunities, threats, and uncertainties, the technique facilitates learning at low real and opportunity costs.

Stakeholder Identification and Involvement is the first step. Those whose interests may be affected either by the plan or by its consequences include top management, key middle managers, customers, stockholders, suppliers, and regulators.

We may ask stakeholders to forecast the future environment, then use Delphi and cross-impact techniques [23] to help structure and formalize judgmental forecasting. These tools help sort those key variables for which forecasts vary around a central tendency from those for which forecasts diverge. Continuing divergence reveals different assumptions regarding structure in the future, and is the ideal base for scenario building.

Building Multiple Scenarios requires special knowledge and skills, plus cooperation between functional specialists and external experts. The key task is to identify those decisions which are most sensitive to environmental factors. Figure 3 models the scenario development process. From **current decisions**, alternate paths lead through **task-related factors** (*e.g., internal economics, constraints to market entry, demography, political developments, etc.*) that may affect the outcome of each decision. The next ring contains **remote forces** (*e.g., world economy, changes in values and lifestyles, trade blocs, etc.*) that determine the future values and states of these forces [24].

Figure 3: Four Scenario Logics



Each vector (arrow) in Figure 3 represents a "scenario logic" allowing planners to test the robustness of alternative strategies under varying assumptions about an **unknown future**. They focus on the interplay between environmental forces and decision factors [25]. A scenario must represent the few dimensions of an alternative future critical to the decisions actually at hand.

Selecting scenario logics (two to four are usually enough) is next. For example, a network operator considering a major new investment in retail transaction technology would first identify critical variables in its task environment. These might include national telecommunications standards, internal procedures governing transactions, and relationships with potential vendors. Factors in its remote environment include growth in personal incomes, local and international policy governing currency flows, user perceptions of service value, plus performance, cost, and access to national and regional telecommunications infrastructure.

Three scenario dimensions, each with only two states, might economically represent the critical institutional dimensions for this operator. Some factors overlap, so the draft set of scenarios can be reduced from eight to only the following four:

Figure 4: Electronic Money Scenarios

SCENARIO/ *Structure*	*Media*	*Channels*	*Policy* ***Regime***
Free Market Forces	Differentiated	Many	Laissez-faire
Thousand Flowers	Differentiated	Few	Laissez-faire
Credit Card Redux	Standardized	Many	Laissez-faire
Very Visible Hand	Standardized	Few	Controlling

Free Market Forces is the scenario logic which expresses best the normative model of the neoclassical school of economics. There are many media types within competing payment channels, and governments are little involved in regulating the flow of funds through these channels. Efficiency stems from fierce competition among the various choices. While this may not be a realistic scenario, it is a reasonable baseline.

In the **Thousand Flowers** scenario, the logic pattern is similar to the computer industry in the 1965-1980 era, or today's desktop software industry. While the small group of competitors dominating electronic money channels are able to capture huge margins from their oligopoly market, they continue to reinvest a large portion of their profits in new functionalities, thus forming a barrier to keep potential entrants at bay.

The **Credit Card Redux** scenario reprises the basic logic of the introduction and use of credit cards in North America, in which many operators emerged to provide differentiated services to specific (often local) markets. Although a single media standard dominated the new industry, this enabled large economies of scale in hardware and software production, and facilitated interoperation between card operators and merchants, but also limited the pace of innovation in many domains. Government played a very small role in the rapid diffusion of this innovation throughout the society.

The **Very Visible Hand** logic reflects reactions by powerful agencies to percieved threats posed by electronic money to their revenue or control over currency flows. To facilitate effective monitoring and control of the growing use of e-money, these agencies would sponsor legislation to expressly prohibit anonymous media, capture data for tax agencies, and filter large international transactions. Short-term licenses would limit the number of competitors, and ensure their cooperation with government agencies. An important side effect is "freezing" the business and technology model earlier in its life cycle than in the other scenarios.

An alternate scenario building technique works back from critical variables (such as GDP per capita in cities or the unit cost of smart cards in the year 2005) toward scenario logics. For any technique, the final set of scenarios should: [26]

- **Embrace relatively long time frames,**
- **Focus on a set of related choices,**
- **Examine environmental trends and events,**
- **Represent the full range of uncertainty,**
- **Be attuned to the current environment.**

Good draft scenarios illuminate the critical issues, threats, and opportunities emerging from each scenario, and help identify those policies which will be the most robust in more likely outcomes. The focus then shifts to task-level factors that may affect the outcome of key decisions. At each step, multiple scenarios highlight specific needs for domain knowledge, define boundaries for analysis, and differentiate the critical variables.

> "Much computation brings triumph,
> little computation brings defeat.
> How much more so than with no computation at all.
> By observing only this,
> I can see triumph or defeat."
>
> Sun Tzu c. 300 BC

Conclusions

As the world's first Internet-based bank, Security First Network Bank (SFNB) provides a window to the future. Its online business model, far more efficient than traditional banking, enabled the bank to cut operating costs while providing superior customer service. However, we have only a hazy view of its long term viability. In response, global banking firms and specialized software companies are likely to forge strategic alliances to seek the potential synergy between the two business types. The three-way joint venture between Windows Corporation, the personal finance software firm Intuit, and Visa International is an early example.

Service firms are likely to face intense competition from non-traditional competitors. Thus, strategic alliances among software development firms, Internet service providers and local banks may be required to defend current customer relationships.

On the technology front, we see that firms with software development strengths have a potential source of competitive advantage, because software lies at the heart of both banking and networks, and the future of electronic commerce seems likely to require integrating a wide range of new hardware devices into network applications. For example, wireless terminals would provide both mobility and instant access to financial information and resources, while smart card readers would become standard on every PC and public telephone.

Another key competence will be leveraging information to enhance customer service [27]. By extension, our analysis suggests that critical success factors for many other service firms will be to maximize the value of customer assets and improve service product distribution efficiency [28]: Here banks lead the way.

1. Maximizing the value of the customer asset means the firm must understand its customer, learn more about market segmentation and client interests, then focus all their energy on exploiting their relationships with customers. Networks are ideal tools to support such objectives.

2. As cost effective design, production, and distribution of online financial products requires substantial organizational skills, plus competence in software development and I.T. operations, firms without these assets will be at a disadvantage.

In summary, although many important factors remain unclear, network-based electronic money appears poised to dynamically alter global relationships between retailers and the banking industry. As the e-money trend materializes, the resulting transformation in retail banking will be as radical as those brought about by deregulation and globalization combined. The business risk for Asian banks, whose current investments in network technology lag behind their global competitors, is likely to be dramatic. Thus, Asian network operators have an opportunity to invest in this business, and use this investment as the basis to form alliances with banks on favorable terms.

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The Use Of Information And Communication Technologies In The Home: A Focus On Electronic Money

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1. ABSTRACT

This paper examines the way people use information and communication technologies (ICTs) in the home. The users' perspective changes the questions, focusing on users' activities, social and cultural values, rather than the possibilities and supply of ICTs and organizational issues. The detailed focus is on the way consumers mix and match forms of physical and electronic money for different kinds of payments. The use of a particular mix of forms of money is influenced by socio-economic factors influencing access; information dimensions such as timeliness, range, immediate record and context; and a person's trust in the reliability of information.

2. INTRODUCTION

Studies of the use of information and communication technologies (ICTs) in the home have focused on the technologies, products and services being offered. Attempts to understand demand have centered around trying to estimate the extent of present and future markets. Though providers of ICTs are intensely interested in the use of ICTs, they have studied this by asking consumers how they use a particular product or service, rather than understanding how a particular ICT fits into a user's life within a particular social and cultural context. Social scientists have been more successful in focusing on the user and consumption. Despite this, "relatively few empirical studies have explored people's everyday experiences of consumption" (Livingstone, 1992, p. 114). These studies have however failed to relate the social and cultural meanings of ICTs to the questions of price and markets which are central for service providers.

In this paper I place the residential user within his or her social and cultural context at the center of the analysis. I use the conceptual and methodological frameworks of sociology to address the central questions of the providers and regulators. The conceptual framework of the study is that the economic and non-economic aspects of social and cultural life are interrelated. Money is a social and cultural phenomenon which shapes and is shaped by social relations and cultural values. This is elaborated in Singh (1994, 1996a). This is why it is imperative for providers and policy makers to understand the social and cultural shaping of ICTs, as well as the social and cultural impact of the new technologies.

The grounded theory approach helps discover these interrelationships between money, technology, culture and society. A grounded study in the manner of Glaser and Strauss, seeks to discover "theory from data" (Glaser and Strauss, 1967, p. 1), rather than prove or disprove a specific hypothesis. Instead, one begins with an area of study, and in the process of data collection and analysis, one discovers the questions and the key concepts. Data collection, analysis and theory influence each other in a "reciprocal relationship" (Strauss and Corbin, 1990, p. 23). This is to be done systematically, so that the theory "fits" and "works" (Glaser, 1978, p. 4). This approach is compatible with the focus on the user as an "actor-in society" (Smelser and Swedberg 1994, p. 5).

In this analysis of electronic money I draw on the broader study of the use of information and communication technologies (ICTs) in the home (Singh, Bow and Wale, 1996). I also refer to the study of electronic money (Singh 1996b) that I refer to as the Money On-line study. Both are based on open ended interviews with 47 persons from 23 households in Melbourne and its rural hinterland between March 1995 and February 1996. The convenience sample is over-weighted for middle and upper income Anglo-Celtic households who own a computer, a modem and use personal financial management programs, in order to better study the use of a wide range of ICTs, and particularly the use of electronic money and on-line services. The data were analyzed with the help of NUD-IST (Non-numerical Unstructured Data Indexing Searching Theorizing), a computer program for the analysis of qualitative data. This process of data analysis is discussed in greater detail in Singh (forthcoming).

This paper is in two parts. In the first part (Section 3), I elaborate the way the users' perspective changes the questions, categories and themes at the center of the study of the use of ICTs. In the second part (Section 4), I focus on the use of electronic money and the important questions of access, information and trust.

3. THE USERS' PERSPECTIVE

This study adopts the users' perspective, starting from the questions important to users, rather than the questions asked by providers. This changes the questions, categories and idioms of the discussion of ICTs. It leads to a focus on users' activities rather than technologies; on demand rather than supply; use rather than purchase; social patterns and cultural meanings of ICTs rather than the characteristics of applications or determinants of demand. The central theme that is discovered is that from the users' perspective, the most important aspect of new technologies is not the increasing convergence of ICTs. It is that ICTs enable consumers to mix and match with greater diversity, ways of working, shopping, studying, communicating, gambling, playing and paying for goods and services. Hence the key to understanding residential demand is to understand the reasons why users choose a particular mix of ICTs for different activities in the home within a specified social and cultural context.

Providers of electronic goods and services recognize the value of the users' perspective for profitability and growth. But the move to the users' perspective involves a major shift in the questions that are asked. As Dervin (1992) points out:

> *Almost all our current research applies an observer perspective. We ask users questions which start from our worlds, not theirs: What of the things we can do would you like us to do? What of the things we now offer do you use?... The difficulty is that the data tell us nothing about humans and what is real to them.... (p. 64).*

The difficulty of the shift is demonstrated in the research on the use of ICTs in the home (Singh, Bow and Wale, 1996). At the beginning of the study, we asked users whether they had a telephone, television or personal computer and where they were located in the house, and then progressed to questions of usage and meaning. Even though we had started consciously with the users' perspective, this line of questioning led to placing the ICT at the center of our questioning and analysis. It led us to conclude that the telephone has influenced the way we work, communicate with friends and family, gather information and do our banking.

This ICT centered approach fits in well with a view of the world where ICTs play an increasingly important role, and one where new ICTs are likely to displace older ICTs. This view emphasizes the convergence of technologies and underpins many of the provider based scenarios of the future. However, our analysis of data about space and ICTs showed that it was the users' activities that gave meaning to both the ICTs and the spaces in the home. If the users' activity was placed at the center, then the thrust of the questions and possible conclusions from the data changed visibly. ICTs were then seen as only one of the ways people sought information about an activity or performed the activity within a given socio-cultural context. In the case of shopping for instance, a person can get information about goods and services from friends and family over the phone or face to face, or learn of it through a newspaper, catalogue or television; order it over the phone, in person or over Internet; pay for it in person, by mail, fax, phone or Internet.

This alerts one to the three interrelated dimensions of any activity, that is information, content and transaction. Taking the example of shopping again, it is important not just to ask whether a person will shop on-line, but to ask whether a person will seek information about shopping on-line, transact for it on-line, and in the case of information and software, receive it on-line. This conceptualization of an activity is itself an ideal type, for it does not encompass all the particular variations. For instance, with an activity like banking, the transaction is the content, whereas with education, one can more easily separate information about courses offered from the actual course and then from the payment for the course. The transaction element can in activities like shopping be further usefully distinguished into the order and purchase aspect of the transaction.

It is important methodologically to distinguish between these three aspects of an activity, for consumers have traditionally had options to conduct these aspects of an activity differently. It also helps to point out that the traditional way of conceptualizing the supply of goods and services in terms of a linear value chain does not fit the way users approach activities. A more useful model is one which represents these features as intersecting circles, illustrating that they come together at some points but can be conducted independently at others. The new technologies have increased consumers' options to mix and match ways of performing different aspects of an activity. Hence from the users' perspective, the important features of the use of ICTs is diversity rather than convergence; a mix and match rather than substitution.

The users' perspective alters the framework and direction of questioning. It is like the shift of a kaleidoscope, where the same data falls into different patterns. However, these new frameworks and questions have to be painstakingly discovered by listening to consumers talk of their lives, for much of the public debate is couched in the terms seen important to the providers.

The difference between the users' and providers' perspectives is very clearly seen in the study of electronic money and payments. Research on payments issues has focused on the payment instrument, the transaction mode and the way changes in these will make for changes in the structure of the financial organization, competition and cooperation. Research on the use of payments services from the providers' perspective focuses on whether a person uses cash, checks, plastic cards; whether a person uses the branch, ATM or EFTPOS. The focus on the technology and products emphasizes the convergence of digital technologies and leads to the view that electronic payments instruments such as stored value cards and electronic transactions via the telephone, Internet and the PC will replace physical payments instruments and transaction modes.

The Australia New Zealand (ANZ) Banking Group's submission to the Financial System Inquiry exemplifies the providers' approach, when it states that ATMs, EFTPOS and now increasingly, telephone and PC banking are making the old "'bricks and mortar' bank branch networks obsolete.... Stored Value Cards (SVCs) may over five to ten years largely displace cash payments for frequent, low-value transactions such as convenience purchases" (p. 29). This view of the old being replaced by the new is followed by an examination of the cost of physical and electronic transactions to the bank concluding that "It costs ANZ about six times as much to service a withdrawal across the branch counter as it does through an EFTPOS terminal" (p. 29).

The National Australia Bank (NAB) in its submission to the Financial System Inquiry also charted that by the year 2005, consumers will use EFTPOS, Stored Value Cards (SVCs), ATMs and then the teller - in that order - to get cash into their wallet. This compares with the present scenario where it is ATM first, followed by the teller and then EFTPOS. It saw a similar migration from the teller to the bank mainframe to put funds into the account (National Australia Bank, 1996). Though NAB's account of the present and future acknowledges the continuity of physical payments and transaction systems, its presentation in terms of number of transactions gives the picture of an unquestionable dominance of the electronic within the next five to ten years.

The problem with this scenario is that it does not take into account that the new technologies diversify ways of payments rather than necessarily leading to substitution. In the past, banks have failed to predict this diversity of usage and hence the necessity of funding both the physical and electronic distribution networks. In the United States, it has been estimated that the introduction of ATMs in the 1980s added $US 5 billion in operating expenses, while saving only $US 200 million in savings from reduced teller positions (Mendonca & Nakache, 1996, p. 142). In Australia, the increasing fees on transactions cost banks customer good will. At the same time banks have also failed to make the costs of payments services transparent, for as Mair (1996) of the Reserve Bank of Australia notes that "for the most part, banks and others have been reluctant, or unable, to pass the full cost of providing check payment facilities back to consumers" (p. 11).

The providers' perspective is important in charting the growth of the use of new technologies. However, if this picture is not complemented by one that places the user and his or her activities at the center of questioning, then it can make for costly misjudgments. As Kyrish (1996) has documented in her work focusing on business and media predictions relating to videotex, online services and Internet from 1981 to 1996, "Predictions that are based on conceptual, normative advantages of technology appear most likely to fail" (p. 26). They rest on assumptions about the take-up of technology which are not based on an understanding of how individual residential consumers use technology. In particular, the judgments about cost of services by the provider are not the same judgments made by the consumer. As the Consumer Credit Legal Centre's submission to the Financial System Inquiry details, for the consumer the stored value cards may be a costly alternative to cash with issue fees, renewal fees, transaction fees, reload fees, monthly fees, plus transaction charges with EFTPOS and ATMs (Consumer Credit Legal Centre, 1996).

The question that is at the center of debates on the payments system in the United States and Australia is how banks can persuade consumers to move from physical to electronic payments instruments and transaction modes. As evidenced in a Bank Administration Institute conference on the National

Payments System in the United States in October 1996, the focus is on the number, volume and value of transactions, rather than the way a person uses money. It was recognized that providers of payments services needed to cultivate a relationship with the customer to retain their dominance of the $US 127 billion payments business. Technology companies such as Intuit and Microsoft were positioning themselves between the banks and their customers by satisfying customers' need to manage information about money (Daruvala and Stephenson 1996; Horner 1996; Miller and Mehta 1996). It was interesting to note that this led to questions about how the relationship between the technology companies and banks should be managed, and the value of alliances and common standards in the banking industry. The perspective was so dominated by the centrality of organizational concerns, that there was no discussion as to how banks could discover ways of better understanding customers' payment behavior within the social and cultural context.

The concentration on products, services, technologies and organizational issues continues despite the recognition that the relationship with the customer is the most valuable asset of a bank. As Daruvala and Stephenson (1996) emphasized at the National Payments System Symposium, the banks need to move from owning the payments system to owning "the hearts and minds of customers". However as Horner (1996) observed, despite research on customers' perception of banks and their services, banks have little knowledge of what their customers want. This is despite the fact that it is the single most important strategic move for banks that want to successfully face the challenge from non-bank players for dominance of the payments system.

Part of the reason for the difficulty is that research on users' preferences and needs is most often proprietary research, as it is seen to be central to an organization's competitive edge. Therefore, the conceptual frameworks and methodological underpinnings of this research are not subject to critical review from outside the organization and the industry. In the next section, I show how a sociological approach to the study of electronic money from the users' perspective changes the categories of discussion.

4 THE USE OF ELECTRONIC MONEY

In order to illuminate the way people use money, one has to go beyond the banking categories of payments instruments and transaction modes. These categories are important for banks to assess their products and delivery of services. However in order to understand payments behavior, it is important not only to know whether a person has a credit card, but whether he or she will use it only over the counter, or is comfortable mailing the number, giving it over the phone, faxing it or putting it on the Internet. This combination of a payments instrument and the mode of transaction I term the *form of money*.

From the users' perspective, forms of money can be broadly grouped as physical and electronic, depending primarily on the transaction medium used. Physical forms of money include physical payments instruments and physical transaction media. They comprise cash and checks transacted person-to-person and across the bank branch, post office counter or mailed. Electronic forms of money are those where the main transaction modes are electronic and cashless and paperless payments instruments. These include plastic cards - credit cards, debit cards, stored value cards, smart cards; direct debit and credit transacted physically and electronically and the electronic versions of cash and checks.

These categories of physical money and electronic money are ideal types. Most forms of money lie along the continuum. The success of particular forms of electronic money such as obtaining cash or direct debit via EFTPOS- rests on the fact there is a physical record and it yields physical cash. So one has the situation that physical money like cash exchanged between two persons may have no record; whereas electronic money obtained from the ATM and EFTPOS is accompanied by a physical record and tangible cash.

Thinking in terms of the various forms of money has two results. First, it reminds one that payments have not always been transacted, even in the past, solely within the banking system. Australia Post for instance claims to be Australia's "biggest over-the-counter electronic bill paying and agency banking service, handling more than 150 million transactions each year (Australian Payments System Council, 1996). What is different today is that it is possible to source both payments instruments and transaction modes in the non-banking sector via the use of stored value cards, e-cash, and the Internet.

Second, thinking in terms of forms of money enables one to recognize that electronic commerce has given rise to a new form of Internet money which uses the Internet as the main transaction mode (Singh 1996c). However only 7 per cent of Australian households have a PC with a modem (Australian Bureau of Statistics, 1996). Hence the next question: What are the outer boundaries of access?

4.1 Access to electronic money

Socio-economic factors like income, literacy and education are important for drawing the outer limits of access to bank accounts, plastic cards, personal computers and modems. The latest figures on the public record show that:

- An estimated one tenth of Australian adults have no bank accounts (Singh, 1992);
- Nearly a fifth (18 per cent) of Australian adults have no credit cards (Kavanagh, 1996). A study of the banking patterns of non-English speaking background persons with literacy difficulties shows that two-thirds had no electronic access. Only 17 percent had a check account, so the rest were wholly dependent on cash as a payment mechanism (Singh 1992).
- Though household ownership of PCs is rising fast, only 30 per cent of households have PCs and only seven per cent have modems (Australian Bureau of Statistics, 1996).
- Poor access to bank branches and ATMs is also a limiting factor in some rural areas. The Money On-line study shows this pushes people more to the use of EFTPOS and checks. Checks cashed at grocery stores or service outlets continue to be an important method of obtaining cash.

These socio-economic factors help explain some of the limiting factors of access. They are however less useful for understanding how people with access, use physical and electronic forms of money. This leads to the next question: What makes a person with access, pay with one form of money rather than another?

4.2 Information and payments

The Money On-line study shows that among middle and high income Anglo-Celtic Australian households, different forms of money are used for different kinds of payments. For instance:

- Cash obtained from the branch or the ATM and direct debit via EFTPOS are used with grocery payments. Unlike the United States, credit cards are not generally used for there is a strong cultural norm against buying food on credit. Checks are used when a person has no cash or EFTPOS is not available;
- Checks and cash across the counter are the most popular way of paying for bills;
- Physical cash is most often the only acceptable form of money for both the merchant and the consumer, for incidental expenditure such as parking or buying items of small value. It is also the form of money most associated with gambling in Australia as there is a regulatory prohibition against the provision of credit for gambling and the situation of ATMs and EFTPOS outlets near gaming venues and casinos;
- Direct debit via a standing instruction with a financial institution is used most often for periodic payments such as the mortgage. Unlike much of Europe, it is not a preferred way of paying for other bills;
- Checks and plastic cards across the counter or EFTPOS direct are used for tax deductible expenditure;
- The credit card, where possible, is the preferred way of paying for large items of discretionary expenditure;
- Internet plastic, that is credit cards used over the Internet, is at times used for paying for books, CDs and software ordered over the Internet.

One of the important reasons for the congruence between forms of money and kinds of payments is that there is a match between the dimensions of information yielded by forms of money and the information required by different kinds of payments. The important dimensions of information for forms of money and payments are those that relate to time, range, immediate record and context. The questions behind these information dimensions are: Is it immediate information or deferred information? Is the information on money spent or also money still in hand or in the account? Is the immediate record evidential, discretionary, or is there no record at all? Is the transaction context personal or impersonal, physical or virtual?

Cash obtained from branches and paid in a person-to-person transaction, gives immediate information about money spent or received and money in hand or still in the account. It can yield a discretionary record in that one can ask for a receipt, but if one does not want a record, a cash transaction is the most untraceable of all transactions. Cash received via the ATM and EFTPOS is different from cash in a person-to-person transaction in its range of information, record and context. Most often an ATM or EFTPOS transaction automatically generates a receipt. With ATMs, there is immediate information about money in hand and money still in the account, but the personal transaction element is missing. EFTPOS is similar to getting cash from the branch in that there is a person across the counter, but unlike the ATM it does not give information about money still in the account. This is one of the reasons that people who are uncertain about the sufficiency of funds hesitate to use EFTPOS.

The information yielded by various kinds of cash matches the information required for grocery shopping, incidental purchases and gambling. With grocery money, often the most immediate need is to know how much you have spent, and how much is left. This information is particularly important if the person is operating within a very tight budget or needs to control the flow of money. For most persons, there is no need to account for this money to an outside party. However the attraction of EFTPOS is that it offers a record of expenditure for budgeting purposes and for monitoring the flow of money from joint marital accounts. Similarly for incidental purchases, where the amount of money involved in each transaction is seen as inconsequential, there is not the same need to keep record. Gambling money is different in that most often it does not come from a specific budget, but is seen as part of household shopping or incidental expenses . Hence there is at times a need not to know how much has been spent on gambling (Singh 1996b).

Checks differ from cash in that with a check you do not immediately get informed by the bank about the money still in the account. But with a check payment, there is a belief that you can prove to the authorities or the recipient, that you did send the check and if it is cashed, track it down in your statement.

The credit card transacted across the counter, also has the immediate evidential aspect to the record. However, there is an implicit hierarchy among the forms of money as to which form is seen as more evidential, with the check ranking first, followed by the credit card and then by EFTPOS. It is this greater authority for a check record that makes it popular for paying bills.

Direct debit or credit via the bank differs from checks in that it does not give immediate information about the money spent. That is why direct credit is more often used for regular periodic payments to the bank, where the amount of money spent is known and certainty of payment is required.

Few electronic forms of money have replicated the kind of information available from physical forms of money. This helps explain why cash remains the "most convenient and popular form of payment" for everyday, low value transactions (Australian Payments System Council, 1995) and why the check is the most popular form of retail non-cash payment in terms of value and volume. In 1995, the volume of checks was 38 per cent, exceeding that of credit cards (10 per cent), EFTPOS (13 per cent), ATMs (17 per cent), direct entry credit (18 per cent) and direct entry debit (4 per cent). In terms of value, checks accounted for 35 per cent, compared with retail low value electronic funds transfer at 2 per cent (Mackrell 1996).

4.3 Internet Money

A focus on information dimensions shows the distinctiveness of Internet money, that is e-cash, electronic checks and plastic cards transacted over the Internet. It differs from most earlier forms of money in that it is both impersonal and virtual (Singh 1996c). It is impersonal as there is no identifiable person at the other end of the transaction as with physical cash, check and plastic or with EFTPOS direct. It is virtual as it is not associated with a physical payments instrument like cash and checks, nor does it result in physical cash as with ATM or EFTPOS withdrawals. Internet money also does not automatically generate an immediate physical record which is evidential in nature.

The closest approximation to Internet money is using the plastic card over the phone or fax. But the phone and fax are less impersonal and virtual than the Internet, for with the phone and fax, the potential for personal interaction and a physical record of transaction, is greater. In other respects, Internet money gives the same kind of information as its physical counterparts. It gives immediate information about money spent or received. E-cash like "real" cash will also tell you how much money there remains in the account. It is hard to say how evidential would be the record generated by the Internet.

Internet money is as yet not generally used in households that have Internet. In the Money On-line study, 13 of the 23 households had modems and Internet users. Fourteen persons from 11 households spoke of whether they have bought or would buy on-line goods and services and whether they would pay for them on-line. They split neatly in the middle with seven persons saying they have or would pay with Internet money and seven saying they would not. The seven who said they would were all men. Of these, five of them had already used Internet money for purchasing books, magazine subscriptions, CDs, software and information services from the United States. Two used debit cards and three used credit cards on the Internet to pay for the goods.

The gender dimensions got muddied when one looked at the seven who said they would not purchase on the Internet, as there were three men and four women in this group. Age was not a determining factor in the usage or non-usage of Internet money, as the ages in each group ranged from the 20s to the 50s. All of them were from medium to high income households, as neither of the two households with an income below $30,000 had access to the Internet at home.

Though the lower cost of on-line payments are at the center of industry discussion, persons do not give this as a reason for going on-line with their payments. The reasons mentioned by the users are convenience, speed and the ability to track the different phases of their transaction - for instance whether the CDs are out of stock and there is going to be a delay; whether they have been posted or not. The users also mention they are not worried about the lack of security, as physical systems are perhaps more insecure. This contrasts with those who do not use Internet money, for they are primarily worried about the security of their transaction and the privacy of information.

These concerns are at times connected to their discomfort with the virtual and impersonal context of Internet transactions, which to a lesser extent also prevent some of them from transacting with a credit card over the phone or fax.

The next step in trying to understand payments decisions and behavior is to ask: What makes a person with access, choose one form of money from a range of possibilities for a particular kind of payment? This question directs one's attention to the issues of trust.

4.4 Forms of Money and Trust

The Money On-line study shows that people mix and match forms of money so that, within the boundaries of access, particular forms of money are used for specific kinds of payments. Information dimensions explain why a person would use Internet money to buy CDs and books from overseas, cash or EFTPOS for groceries and pay utility bills by check at the bank branch. The quality of this mix however varies for different households and for persons within the household despite similarities in income, education and computer expertise. Access and information dimensions do not explain why one computer expert feels comfortable using Internet money to buy books and software, whereas another person of the same socio-economic status may order on-line but will not pay on-line? What is it that makes the first person trust Internet money while the second will not?

As Samarajiva (forthcoming) notes, "Little is known about how to create a trust-conducive environment based on interactive media systems" (p. 11). The virtual and impersonal nature of the Internet transaction heightens the issue of security. This has led to voluminous discussion of the technological and legal underpinnings of a secure payments environment. These are necessary conditions, but in themselves are not sufficient conditions for usage, for transactions not only have to be secure but to be trusted to be secure.

Banks have been persuading customers to deposit in ATMs, but without much success. In Australia, the estimates are that only one or two percent of deposits are made through ATMs, while in the United States, even with the new generation ATMs, the figure is said to be five per cent (Allard, 1996).

David Bollier reporting on the Aspen Institute Roundtable on Information Technology, notes:

> *It may be conceptually useful to distinguish between issues of "hard trust," which involve authenticity, encryption, and security in transactions, and issues of "soft trust," which involve human psychology, brand loyalty, and user-friendliness .... it is important to see that the problems of engendering trust are not simply technical in nature.... Trust is also a matter of making psychological, sociological, and institutional adjustments" (1996, p. 21).*

This trust can take a long time and may need a variety of "warranting structures". However some of the factors that help build this trust are the speed with which orders are filled; being able to accurately account for the transaction if need be; a willingness by the seller to rectify errors; voice contact at the order taking stage; and lower prices (Bollier, 1996). These are important supply side criteria and contribute to the user feeling in control of the transaction.

Analysis of the Money On-line data indicates that from the users' perspective, it is this ability to control the transaction that makes a person more willing to trust and use a form of money. Trust and control are intertwined, for trust in the system leads to a sense of being in control, and being in control leads to a feeling of trust. The Money On-line study shows that a person's sense of control comes from the presence of at least one of the following factors:

- A physical payments instrument and/or record of payment;
- A personalized transaction context;
- Ability to track and substantiate a transaction;
- Ensure his or her desired level of privacy;
- Favorable experience of the form of money;
- Knowledge of the service provider and/or the recipient.

The importance of each of these factors has much to do with the culture of banking and psychological factors. This is as true of Internet money as it is for the use of direct debit via EFTPOS or depositing through the ATMs.

5. CONCLUSION

The users' perspective shows that in order to understand payment behavior, one needs to focus on the questions of access, information and trust. These factors influence the way residential consumers use a mix of physical and electronic forms of money to make different kinds of payments. Access, information and trust mark different boundaries of use. Socio-economic factors such as literacy, income, geographic location limit access to physical and electronic forms of money.

Given access, information is the most important factor in the choice of forms of money for particular kinds of payments. This is because forms of money yield information which differs in timeliness, range, record and context. At the same time different kinds of payments, such as housekeeping and business expenditure require a different kinds of information. The selection of one form of money over other possible forms for the same kind of payment is influenced by a person's evaluation of the reliability of information and whether he or she is able to trust the information.

Access, information and trust help explain the continued popularity of traditional forms of money and the gradual nature of change despite banks' emphasis on electronic forms of money. They also help explain why technology firms such as Intuit and Microsoft which have focused on giving consumers control of information about money, have emerged as powerful competitors for banks' payments business.

This study shows the important strategic question for a payment provider is: How does it deliver payment services that answer customers' need for access, relevant information and trustworthy forms of money? It is this question which needs to be at the center of strategy for payments providers.

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Impact of Teletext Technology on Emerging Stock Markets

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Abstract

This paper discusses the technical aspects of a cost effective Information dissemination system for the emerging markets and its impact on shaping the future of these markets.

Introduction

Fair & free markets for developing economies are a must. With increasing globalization, the emerging markets have now become important investment prospects for fund managers through out the world.

It has also become very important for the stock exchanges and other financial institutions of these emerging economies to allow their information to be available freely and easily to investors in the local market, and to fund managers anywhere in the world.

Availability of such timely and reliable information introduces an element of transparency, increases the investor base, their confidence, and sets the pace for the sustainable development of the economy.

It is essential, that the setup and operating costs for dissemination of information far and wide, should not be high. Also the technology be user friendly and powerful enough to reliably carry on-line services.

Teletext, a point-to-multi-point data dissemination system provides an effective and low cost means of distributing on-line information. This information can be viewed on televisions (and can be downloaded on computers) using existing television network.

Because this digital data is encoded in video, it becomes an integral part of the television signal and therefore, can be transmitted everywhere the television signal reaches, without interfering with the existing transmission. No separate TV channel or satellite time is required, a huge saving on the capital investment on setting-up a broadcast station.

The first Teletext based on-line information dissemination Network, in-operation for over a year now, in Karachi and Lahore, was locally designed, developed and implemented. The transmission carries real time stock market quotes, currency rates, local & global weather, Reuters financial information service and other educational & public service information.

At the receiving end, users are provided with locally developed & manufactured Teletext decoders that display the information on televisions, and also allows data-download on computers. Each Teletext Decoder (and every Service) is individ-ually addressable and can be switched on or off from the broadcast station. Windows and DOS based software have also been developed by various software houses to perform analysis on the real-time data being received from the service.

The project has filled the gap for a low cost, user friendly, real-time data dissemination medium and now is being widely used within Pakistan. Such information systems can also be of help to other developing economies.

The paper discusses technical aspects of

- How the on-line information is gathered using WANs,
- Subscription management and accounting,
- Broadcast using Teletext technology,
- Receiving information at the user end
- Information display on TV and,
- Download on-line on computers and software tools

The author also shares his experiences of

- How the project was initiated and materialized
- How the project gained acceptance and popularity
- Technical and financial feasibility for Stock Exchanges & broadcasters.
- Response of the Stock market investors, how it has effected their business.
- Role of Stock Exchanges, Technology companies, Broadcasters and government for such projects in emerging markets.

- Comparison with internet technology
- Future prospects for such technologies in the development of capital markets in emerging economies.

Teletext - an overview

The data to be distributed is encoded in video. It is carried along with the standard television signal using the unused Vertical Blanking Interval (VBI). This data can be received anywhere within the signal range. VBI is a standard part of the television signal but normally carries no information.

At each receiving site, using Teletext Decoder, this data is extracted from the television signal, decoded, and displayed on standard televisions. The data transmission is uni-directional.

Advantages from Teletext systems

Low Cost : A major attraction of the Teletext medium is that it is "free" (or at least already paid for). No new broadcasting station or transmitting power is required, even as the number of receiving sites increases.

A typical teletext broadcast system of 1000 users costs one-tenth of a server based market information system for stock exchanges.

Reach : Teletext is capable of reaching essentially 100% of businesses and households "over the air", in the broadcasting station coverage area. In addition it can also be made available via cable television and virtually everywhere by a TV channel on satellite.

Capacity and Data Integrity : Teletext is a point-to-multi-point data dissemination system. It is a high speed transmission medium with the capability to simultaneously deliver data to an unlimited number of reception sites located anywhere in a given region. Effective data transfer rate of 256 Kbps can be achieved. Error handling is also incorporated.

On-line & Real Time : Teletext data broadcast can be viewed in real time on televisions, computers and display boards. Thus, immediate update of Information in a wide area is made possible by Teletext, 24 hours a day.

Easy to Operate : Use of Teletext service is simple and does not require any training. A person who can operate a TV remote control can easily operate Teletext service.

Download on computers : A major development in the Teletext systems is the interface with personal computers. The same information can be simultaneously displayed on TV screen as well as on computer. Utilizing the power of PC, information can be stored and retrieved whenever required. Several analysis tools & off-the-shelf software are also available for different platforms to store, retrieve and process the information being received, in real time.

Interface with Electronic Display Boards : Teletext decoders can also interface with indoor and outdoor information display boards. This facilitates display of market indicators and trading information in public places. The technology allows simultaneous update of several display boards with on-line information.

Teletext Applications :

- Financial - real time share prices, traded options, currencies, bonds and commodities, market commentaries, company reports etc.
- News - including World and regional News Headlines etc.
- On-line Data Broadcast
- Weather - including both local and global.
- Roads - including roadflashes.
- Flights information
- Sports - live scores & updates, racing results, tips etc.
- Holidays & Travel - flight and info, special and early booking offers, bargains of the day, tourism development etc.
- Entertainment - including cinemas, music, astrology, fun and games, kids, computer games etc.
- Miscellaneous - including regional guides, teen magazine, environment, home and leisure, family finance, whats'on, jobs/advice & much more.

Data Gathering Network for Teletext System

Data gathering network is important and crucial part of a Teletext system. Based on high speed data links, the network facilitates gathering on-line information from different sources. To ensure reliability and integrity of information, the network must be rugged and provide high performance. Wavetech has designed a complete Wide Area Network to collect information from different sources, including Stock Exchanges, Banks, Brokerage Firms, News Agencies etc. The network acts as the backbone for the Teletext system.

Based on the existing communications infrastructure of the country, the network design is modular and different segments can be connected using different mediums. For the designed WAN, following mediums are used

Normal dialup digital telephone lines
Dedicated telephone links
X.25 Public Data Network
VSAT, ISDN, leased line options also exist.

Database Management & Processing

The data gathered from different sources is stored and processed, while being send 'On-Air'. To utilize the bandwidth of the Teletext effectively, data is processed to form value-added information which is easy to understand. Data stored in relational database, includes currency rates, Stock Exchanges' information, market indicators, other financial information etc. Specially developed application software manages the database. Off-Line 'Teletext Data Entry Terminals' are also provided for manually entering the information such as weather, sports updates etc. To manage Off-Line and On Line services simultaneously schedulers are provided which take care of the timely update of all the services.

Teletext Broadcasting System

The processed digital data is sent to the television transmitting station via data links and is inserted in the video signal for transmission. The data can be inserted in either a few or all of the 18 VBI lines of the video signal A typical system can store and transmit 1000 pages of information (one TV screen is termed as one page). This operation is completely automated and is performed by a pre-configured Teletext head-end server. Effective data transfer rate of 256 Kbps can be achieved.

Teletext Reception

Information can be received using Teletext Decoders for the reception of Normal and Encrypted Teletext Service. These decoders provide standard TV signal output for TV sets, VCRs etc. Special teletext decoders, in addition to TV outputs, also have serial port interface for computers, to provide data for various financial software packages. These decoders are operated through remote control and can also be controlled from PC.

Teletext Software - Analysis tools for financial services

DOS and Windows based Stock Market Information and portfolio management software (single & multi-user) for Teletext are available for IBM PC compatibles. Also available are, Teletext based decision support systems for investors and funds managers, on-line bids & offers etc.

These software that interface with Teletext decoders, provide on-line market information, analysis, information on market leaders, top gainers & losers and tools for portfolio management. Complete price movements, summarized reports, queries with option for making hard copies of all the reports. These software also provide graphical analysis, allows setting of alarm conditions for different price levels, export of data in different formats such as Database, Excel, Lotus Worksheet and Text file.

Subscription Management system

The Teletext System also offers features for operation of 'Encryption based services'. Each service can be restricted to authorized users only. Such type of option is very useful, when a value added service is offered on some premium charge. To facilitate such a service, the decoders are individually addressable. It can be remotely programmed from the Teletext Control Center to receive a defined number of services.

Subscription management system provides complete control and reporting for managing subscription accounts for the various services operating on the Teletext System. This feature of the Teletext service provides an option to generate revenues from Subscription Based Services. The system can operate multiple subscription based services.

SIS - A Teletext Service, Setup & Operated in Pakistan

In Pakistan Wavetech operates a 24 hrs Teletext service by the name of SIS - Shalimar Information Service. The service is being telecast via Shalimar Television Network (STN), a private television network, in parallel with its normal transmission. It is available in Karachi and Lahore, the major cities of Pakistan.

SIS carries a variety of on-line and off-line value added services. On-line services include trading data of Stock Exchanges of Pakistan, Reuters financial information services and flight information. Off-line services that are updated on a regular basis include financial analyses, sports updates, weather reports, social & cultural events, TV program schedules, etc.

The Stock Exchange section on SIS comprises of On-line trading information, market indicators, End of day reports, detail quotes for all the companies, Announcements, Renunciations & Payments schedule, Book Closure Dates, Board Meetings, etc. A comprehensive Financial Analysis section is also available for investors to make better investment decisions.

How Teletext Project was initiated

The services & products development center at Wavetech works for finding new technology applications. They are in close contact with businessmen, economists, local government, stock exchanges, brokerage houses, banks, investors and frequently conduct formal & informal surveys. Members of this team explore on internet, they attends seminars, trade shows and subscribe to several technology magazines. They understand that a technology which is IN in a particular society may not be THE technology for another society. Some customization, tailoring, and sometimes a totally different solution may be the answer.

Teletext Technology was the right selection for data dissemination in Pakistan, a typical example of a developing economy with increasing interest from foreign investors in form of portfolio investment and direct investment. The technology caters for the needs of foreign investors, their local representatives and the local investors.

The requirements analysis of the complete system was conducted by a team represented by Financial market experts from the Karachi Stock Exchange and technologists from Wavetech.

A project feasibility was submitted to the Stock Exchanges and the Broadcaster. It was evaluated and approved. The development and integration was done by Wavetech.

How the project materialized, gained acceptance and popularity

To disseminate the Stock Market & financial Information by Teletext, three institutions must play their part

1. Stock Exchange & financial institutions
2. Broadcaster
3. Technology company

In Pakistan's case Wavetech as the technology company designed, developed and implemented the concept for the stock exchanges & financial institutions of Pakistan. Now a comprehensive system is available for other stock exchanges and broadcasters.

This dissemination of financial information by Teletext has benefits for all three organizations plus the information recipients, major benefit being the very low setup and operation cost.

Advantages for Stock Exchanges

- Far & wide dissemination of on-line - trading information at a low cost
- Increased transparency
- Increase in investor base
- Increase in liquidity
- Easy availability of reliable - information to investors
- Revenues from service subscriptions

Advantages for Broadcaster

- Added service on the existing channel without additional cost
- News, Program Schedule, Advertising, Weather, business, hotel information and other value added free and subscription based services for clients
- Revenues from data broadcast

Advantages for Teletext Operator

- Revenues from Subscription - management
- Advertising

Advantages for Viewers

- 24 hrs Text channel carrying on-line information bank.
- Investment guidelines
- On-line stock market information, currency rates, breaking financial news and announcements
- Easy to view on TV & download available on computers.

Advantages to the Economy

- Increased Investment as liquidity, transparency and investor base increases.
- Increase in Growth rate as the market develops
- Increased awareness among the public.

Response of Stock Investors

Teletext service has seen wide acceptance from the Investors. Now an investor can see his transaction being executed on the floor of Stock Exchange, he can make better at-the-moment decisions, plus he can analyze the market trends remotely. Teletext has increased overall investments-literacy and confidence of investors.

People are becoming aware of maintaining there own portfolios and are making more transactions as the on-line information is available to them. General satisfaction level of the users is good.

Almost 55% of the present service users are computer literate and use various software tools. Others watch Teletext service on Televisions. 25% uses both television and computer. According to one investor, he has recovered his investment in Teletext decoder within a month.

Role of various institutions in setting up of a Teletext Service are as follows;

Stock Exchanges : Provide Trading information for the Teletext system

Television Broadcaster : Provide assistance in commissioning of equipment at broadcast station and aid in marketing the service.

Teletext Operator : Carry out the technical setup requirements and operate the service, plus effectively market the service. Also reliably install and maintain the receiving sites.

Governments : Act as a catalyst in formation of such an alliance and provide legal framework and support to such operation.

Teletext and Internet - Suitability for mass data distribution

For internet technology, user must be computer literate and afford a computer which runs Windows and Internet client software. This is essentially true for USA, Japan and some parts of Europe, and these are the regions which have almost 85% of all the computers and internet users of the world.

In the emerging markets and developing economies, computer literacy is very low and per capita income of these economies depicts inability to own a computer. Since a TV is ranked much higher than computer in the list of necessities anywhere also because of its user friendly nature, it is much easier for people to view information services on Televisions.

Teletext can disseminates information to a city or a country of tens of million of people simultaneously. Infrastructure cost for serving so many clients through internet exceeds many folds, whereas, the cost of providing the same information through Teletext considerably decreases with the increase of receiving sites.

For example, in Pakistan, the rate for internet connectivity is around $3 per hour. A stock investor who needs information for 5 hours daily would end up paying approximately $330 per month, this is atleast 10 times higher than monthly cost of Teletext service. At the service provider end, the cost varies directly for increased internet clients since more infrastructure is required in terms of servers, telephone lines and processing power. Also the service performance is inversely related to number of clients on an internet server.

For Teletext systems, data is broadcasted and no costs are added with increasing numbers of clients.

This does not mean that these economies should not invest into Internet services. Teletext complements Internet applications and is suitable for wide dissemination of data simultaneously.

Future prospects for such technologies in developing economies : Conclusion

Teletext based on-line financial information dissemination system has been tested out extensively in Pakistan and in other parts of the world. It has proved to be effective and efficient mode for stock market data dissemination. It is being used in America and some of the European countries as well. But it has not catched on in these countries because of three main reasons;

- Developed Communications Infrastru-cture exists in these regions
- Higher degree of Computer literacy has opened other options of data communications.
- Already developed markets can afford higher cost solutions.

The need of developing economies and emerging markets is that technology advancement should be planned and implemented in phases that are sustainable and financially bearable for these countries. The users must be able to avail full advantage from the information system on a user friendly medium at an affordable price. This situation holds true for the Emerging Asian Markets, Central Asian republics, Latin American Markets, Africa and Eastern European Block.

The cost of internet connectivity is still high for users in these regions and computer literacy still not so common. Teletext offers low cost data broadcast, for televisions and computers, unmatched by any other data broadcast system.

TELEMEDICINE: HOPES, REALITY AND THE IMPACT ON TELECOMMUNICATIONS

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1. ABSTRACT

Telemedicine (the interaction of telecommunications, computing and medicine) could have significant impact on health care. Whilst hopes are high that telemedicine can make a major contribution to the provision of universal healthcare (and reduce the cost of that provision), these hopes are tempered by a reality that large scale deployment faces many issues outside the bounds of the technologies. However successful application of telemedicine will have a dependence on the provision of appropriate telecommunication services.

2. BACKGROUND

2.1 DEFINITION OF TELEMEDICINE

Telemedicine has been defined (1) as "any system of medical care in which a doctor and his patient are at different locations". Practically, the technology ranges from video links to telesurgery (the concept of remote surgery).

Telemedicine has two principal objectives:

- To allow patients living in remote, isolated or rural locations (not necessarily in the countryside) equity of access to healthcare.
- To optimise the efficient and effective use of medical staff and resources in managing patients who may otherwise not have ready or easy access to services.

2.2 DRIVERS FOR TELEMEDICINE

In the last 50 years health care has changed dramatically and the following 3 factors perhaps represent the dominant issues of today:

- Complexity of medicine means that expert advice is more frequently needed.
- There is an expectation of a universal level of healthcare.
- Budgets for health care provision are constantly rising (yet not satisfying demand) so any approach that has the potential to reduce costs is of interest.

The main feature contributing to complexity is the range of treatments available, which depend on a precise diagnosis of the condition. Diagnostic tools and treatments are constantly changing. It has been estimated that an effective doctor needs 2 million pieces of information, most of which are being constantly updated.

The consequences of the 'global village' mean that 'fashions' for treatment change with extreme rapidity and traditional medical expertise has an overlay of innovation where the number of experts may be low. Telemedicine offers the opportunity for those few experts to disseminate specific advice to local practitioners. In particular it offers opportunities for 'internationalisation' of health care (2)

All countries with a developed health care system, whether nationalised or not, see an increasing proportion of GNP devoted to health care. The result is that a crisis is being created in the health services. In the USA, for example, health care costs have steadily risen; from under 6% of GDP to over 12% of GDP over a 30 year period (an average increase of over 3% year on year).

Recent crises, as a result of this growth, have occurred for those funding healthcare. In the USA, concerns led to a dramatic decrease in the market value of the Health Maintenance Organisations (which cover 20% of Americans) (3). In the UK (with a largely publicly funded health service) major issues have arisen over funding, especially of health service pay.

3. HOPES

3.1 EQUALITY OF HEALTH CARE ACCESS

Modern healthcare is structured at a number of levels but 'specialist' care is usually focused on a 'general' hospital where a wide range of specialities are centred. This currently requires a critical mass (in terms of specialities) to provide adequate cover. With increasing globalisation the expectations are that similar levels of health care can be delivered throughout the developed world as well as the major centres of lesser developed regions.

In developed economies the practicalities of accessing the less common specialities from the remoter regions can be difficult and even when available, visits to specialist units are time consuming and difficult for the patients. Telemedicine offers the possibility that preliminary consultations, at least, could be conducted across a communications link. Longer term, the benefits could be that large central hospitals could be replaced by 'distributed' hospitals, smaller compact units with communications links to 'core' facilities in other units. Lathrop (4), in a study of US hospitals, concluded that many benefits could be achieved through reduction in hospital size. His considerations focused on the management of hospitalised patients and telemedicine could make size reduction viable.

However other parts of the world may offer greater potential for developing new approaches using advanced technology (which need not equate to high cost). Indeed such an approach is likely to be more beneficial in remote regions when, for example, in some Pacific Island states tertiary care may be well over 1,000 miles distant (and in a different country!).

3.2 INCREASED EFFECTIVENESS

In 1993 the management consultants Arthur D Little concluded that telecommunications information applications could reduce the USA health care bill by $36 billion.

Management theory (5) suggests that progress is achieved in a series of waves, advances are incremental up to a certain point and then, beyond that point, decline sets in. Further progress has to be through a 'leap' with a breakthrough.

Health services, in most developed countries, are struggling as organisations and telemedicine could provide that breakthrough. This is not to suggest that technical breakthroughs are not being made at an increasing rate, rather that the burden of cost, as a proportion of GDP, is beginning to become unsustainable.

The current state of development of telemedicine has progressed from the initial 'naive enthusiasm' to a 'somewhat hopeful' stage! The challenge is to move past these phases into practical demonstrations of increased effectiveness! Only wider application will allow evaluation of financial benefits, when pilot scheme are exposed to a harsher world.

The new wave is likely to be global in its implication. A hospital in the USA (6) is linked to a centre in Saudi Arabia to provide specialised diagnostic facilities - two thirds of the way round the world! For applications in the Pacific Islands significant distances also apply. Telemedicine is exceptionally suited to this task.

4. REALITIES

4.1 PRACTICAL UTILISATION

In the UK some ambulance crews have been linked to hospital Accident and Emergency Units, providing advice to the ambulance crews and giving hospitals advanced warning of the condition of patients. In the USA the Colorado State Division of Corrections is evaluating the use of telemedicine to provide secure healthcare in prisons (7). However virtually all applications have been in the form of 'pilots' and, whilst demonstrating the use of telemedicine, are difficult to evaluate from both clinical and financial perspectives.

4.2 RECOGNITION OF NEED

Patients benefit, through the provision of facilities using computer based technology, from remote access to specialist doctors. The G-7 Global Healthcare Applications Project set up at the Brussels G-7 Conference in February 1995 identified six sub-projects, one of which (Sub-project 4) is aimed at providing emergency medical services, regardless of location and delivering a 24 hour, multi-lingual service.

The Organisation for Economic Co-operation and Development provides assistance for developing economies through the Development Assistance Committee. In telecommunications both technical and financial assistance are provided with "target countries having an approximate per-capita GNP of less than $1,300. Moreover the focus of this aid is placed on basic human needs, areas such as medicine and education, which have low profitability yet are indispensable to human life. ....emphasis is put on the relatively poor nations and especially rural areas" (8)

The World Bank, in reporting on health care in developing countries made recommendations which can be paraphrased as:

- Improve basic living conditions and understanding of health issues
- Redirect 40% of current health expenditures to public health and essential clinical services - this should reduce the burden of disease in developing countries by 40% - averting 9 million infant deaths
- Increase private sector investment in health

A year later in reviewing the needs of Africa the bank set out a similar 3 point plan:

- Improve conditions and education
- Make a basic package of cost effective-health services available to Africans near to where they live through health centres and first referral hospitals
- Progressively move away from less cost effective interventions (largely provided through tertiary facilities) to a basic package

The deployment of innovative technology can involve not only market forces but also be politically driven! Political lobbying, whether overt, covert or even displaying self interest can make a significant impact!

4.3 ECONOMIC CONSIDERATION

The economics of telemedicine are difficult to quantify. In the first place the cost of telemedical practice is difficult to estimate whilst still in a developmental stage. The costs are related to the provision of equipment which may be a 'one-off' and staff utilisation requires apportionment between staffing costs and development costs.

The cost, at a national level, of providing health care can be identified as:

- Direct costs i.e. cost of hospital services
- Economic loss i.e. working days lost to business or lost productivity
- Indirect costs - travel to hospital by patient and family etc.

Normally only the first factor is considered but recognition of the second two factors is beginning to emerge.

The need to identify the ways in which prices are used within a 'near monopoly', as nationalised health services are, is complex and reflects similar issues to transfer pricing in multinational organisations.

4.4 APPROPRIATE TECHNOLOGY

The use of 'appropriate technology' is likely to become a more significant issue in the future. Until recognised standards emerge (that have widespread acceptance) there is a danger that each system will be tailored to specific needs. However successful implementation is likely to arise if equipment is 'tuned' to requirements. This is especially valid if consideration is given to the different needs between developed and developing economies. One example is the debate on transmission bandwidth; should it be over a voice line, or a higher speed, or in one of the many data packeting (e.g. ATM) options? This needs determination of what information is essential; how should it be sent, how much detail is required etc. The clinician's response is that it will vary according to the type of case being considered. Effective implementation requires as much commonality as possible.

4.5 ORGANISATIONAL FACTORS

Despite the high hopes expressed by many at the fringes, the reality is that many hurdles, unrelated to technical issues, need to be overcome before extensive penetration of the technology can be expected. In developed countries, the issue of who is ultimately responsible for the patients (especially when success is not achieved) promises to cause long-term debate, from professional, legal and insurance viewpoints. In developing economies, issues of funding and infrastructure dominate, associated with the requirement to prioritise need.

It should also be recognised that telemedicine cuts across organisational structures, lines of responsibility and budgets. The impact of large scale deployment would result in significant organisational changes within a professional organisation used to autonomous responsibility. Perfecting the technology and determining the operational structures needed is only a start.

5. IMPACT ON TELECOMMUNICATIONS

5.1 TECHNOLOGICAL CHANGES

Technological advance facilitates the development of telemedicine. Developments in telecommunication technology such as fibre optics and synchronous networks (SONET and SDH) are especially relevant. The former provide practically unlimited capacity with extremely low error rates, regardless of distance. The latter enable highly resilient networks to be constructed, providing flexible configurations for very high speed transmission. Satellites also play their role, especially in access remote parts of the world, having the capability of rapid deployment, invaluable in disaster situations.

Medical equipment such as Magnetic Resonance Scanners (MRI) and Computerised Axial Tomography (CAT) which utilise computerised imaging systems, mean that patient data is amenable for direct interface with telecommunications systems and information of equal accuracy can be made available at any suitably equipped location.

Other relevant technologies are also emerging, for example virtual reality systems and robotics systems which make the concept of telesurgery a 'near horizon' possibility. Low time lags of modern networks mean that 'keyhole' surgery, currently achieving significant utilisation, could feasibly be extended to remote sites. Control systems providing robotic operating arms appropriate for telesurgery are currently being evaluated (9).

5.2 INVESTMENT DECISIONS

Telemedicine has the potential for utilising large amounts of 'bandwidth', and significant use would not only restructure health services but have major impacts on the deployment of telecommunications. Indeed in some scenarios it is possible to envisage health services of the future being the driver for network infrastructure.

In industrialised countries it may be that tariffing flexibility will be the key. At the present time the concept of acquiring significant capacity (say STM-1/OC-3 and higher) has not had a major commercial focus but it is likely that major utilisation may require new approaches.

Indeed, it could be that investment decisions and funding pass from the telecommunication service providers to the health service providers, a concept that may be more appropriate in rural regions.

5.3 NETWORK ISSUES

The requirement for telemedicine will vary from the undemanding to the extremely demanding. The attributes in the latter case will include

- Zero transmission error rates.
- Very fast recovery from link failure.
- Low (and consistent) transmission delay.
- Secure links (protected against both interception and disruption)
- Broadband capability (on demand).
- Validated performance monitoring (to satisfy medical regulatory authority)

Whilst this is a demanding list, most elements are available within synchronous network parameters. The last item could prove the most difficult; if telemedical links are deemed 'medical equipment' they could become liable to state and national medical device licensing adding extra complexity especially if inter-state or international procedures are involved.

5.4 ROLE OF GOVERNMENT

Governmental organisations are beginning to recognise the issues posed by telemedicine and this is reflected in the US Senate "Comprehensive Telehealth Act of 1996" which seeks to remedy many of the constraints faced by telemedicine and providing central funding (initially $25 million pa).

A further issue that causes concern is network security. Whilst there are a range of sub issues associated with the subject, questions arise that require much more rigorous approaches than are considered in normal hospital environments. However these concerns must be taken seriously and met not only with technical responses but placed in a formal framework. The Council of Europe has a recommendation on the protection of medical data in draft.

6. CONCLUSIONS

6.1 ISSUES

'Regulatory' factors, and associated human resource issues are identified as potentially the most difficult hurdle to overcome and work still needs to be carried out to determine how major telemedicine systems can be implemented in both clinical and administrative management terms - providing a framework for research and development.

External organisations (government and non-governmental, national and international) can smooth the path of the potentially radical changes that would be the result of wide spread use of telemedicine.

The dominant inhibiting factors lie within the trappings of the professional structures of the health services and may be summarised as:

- New ***organisation structures*** within medical services will be needed to efficiently and effectively use resources.
- ***Legal and regulatory*** barriers need careful review
- More studies need to be carried out on the ***rationale*** for introducing telemedicine.
- ***Cost implications*** resulting from the introduction of telemedicine are not fully understood.
- Development and deployment needs to be co-ordinated at an ***international*** level if smaller and less developed nations are to benefit.

6.2 THE FUTURE

Long term the question arises as to where telemedicine is heading. In broadest terms it is provision of medical care over a telecommunications link. Already some work has been undertaken with Knowledge Engineering to determine appropriate action and the exact nature of both the patient interface and advice provider is likely to develop in a way which is not readily predicted today. It must be recognised that health service provision extends way beyond the drama of TV to more basic care.

One of the key factors that must be carefully assessed is discerning between real sustainable systems and 'demonstrators' or prototypes. Whilst the latter are an important and necessary stage in the development of a concept, they do not represent optimised solutions, whether considered from production, user or support viewpoints. Much of the work being undertaken was found to fall into the prototype category.

6.3 MOVING FORWARD

Stout (10) observes that "One does not forecast the future; one creates it", identifying three C's:

- **Collaboration** along the whole chain and across the whole net involved in the delivery of innovations to the ultimate customer
- **Confidence** that the future can be created
- **Communication** of knowledge that may have a thousand uses.

Those involved in telecommunications need to collaborate with those in healthcare to identify viable programmes that utilise telemedicine in a practical and cost effective manner and to communicate the benefits to both practitioners and users.

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Interactive Communications Policy and the Health Experience.

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Policy and technology are two sides of the contemporary global coin. Policy is the art of the possible, technology creates the opportunities. The paper will discuss the pragmatics of policy and technological interaction and the communications processes which are necessary to link the economic and social forces through political action to achieve widespread deployment of information technology and telecommunications in health services.

These include a Delphi research project on professional attitudes to telemedicine, including the identification of legal, financial and attitudinal barriers to the introduction of new services.

The case studies involve the political and technological issues which are becoming resolved in the central time zones of Australia (longitudes 120 - 145E). The scenes are being played out within the South Australian Health Commission, in mutual arrangements between the South Australia Northern Territory governments, at the Australian Health Ministers Advisory Council and APEC and amongst a cluster of commercial enterprises.

The major technological developments include the use of video conferencing to deliver consultations, visits and specialist opinions, the development of smart, longitudinal patient records, and the development of interactive medical curriculum and health information services using aggregated ISDN, satellite, internet, intranet and CD-ROM.

The benefits include access to health services, cost effective remote service delivery and improvements to service quality, from the capabilities and skill base of the professionals, to the development of culturally sensitive services, designed and managed by remote, indigenous communities.

It will be shown that tele-health services provide a key element in the South Australia's policies covering access to medical services for people living outside the metropolitan areas, and the development of a new economic base in the information industries and trade in services.

Telecommunications in the Service of Humanitarian Assistance: Towards an optimum Use of Telecommunications in Disaster Management

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Cyclones, costal floods, river floods, droughts, earthquakes, tsunamis and volcanic eruptions are, unfortunately, more common in the Pacific region than in most other parts of the world: Five of the fourteen Pacific Island Countries listed in a report of the World Conference on Natural Disaster Reduction (1) are prone to all eight types of potentially catastrophic events, and none has to fear less than six of them. The Pacific coastlines of America and other locations not covered by this report have experienced some of the most dramatic events in the past few years - the earthquakes of Kobe, San Francisco, Los Angeles and Sachalin are prominent examples.

Natural hazards threaten all social and economic sectors: Housing and community buildings, agriculture, tourism, commercial and industrial activities, transport infrastructure and public utilities (2). Disaster mitigation, prevention and preparedness, as well as disaster relief have therefore a high priority in the region.

Telecommunications play a vital role in all disaster mitigation and response activities: The gathering of real-time information depends on them, and so does the dissemination of early warnings, the alert and mobilization of assistance and the coordination of relief operations. Today's telecommunications industry provides a multitude of tools for these tasks, and telecommunications services support the corresponding applications. Satellite based global mobile personal communication systems (GMPCS) will, in the near future, complement the cellular networks already established in many locations (3), and data networks already allow the real time exchange of virtually unlimited volumes of information. At the same time, deregulation, interconnectivity and global roaming are among the most popular items on the agenda of telecommunications related conferences world-wide.

Why, must one ask, is it under such favourable conditions necessary or even appropriate to put the subject of telecommunications in the service of humanitarian assistance on the agenda of the PTC conference? The sad answer is: Because telecommunications policy has, in spite of the emphasis on the above mentioned key words, not kept up with the progress of telecommunications technology.

In many cases, the needs created by a disaster exceed the locally and nationally available resources. International assistance then becomes indispensable, particularly in a region with a large number of independent states and islands, many of them small and far from wealthy. International assistance means also the need for transborder use of equipment: The telecommunications infrastructure of the affected location is likely to be damaged or destroyed, and any surviving public networks will be overloaded, the appropriateness of any assistance, however, depends on continuous feedback to its providers. The effectiveness of the work at the site requires real- time coordination among and within rescue teams - not the least for the security of the relief workers who often risk their life in the service under extreme circumstances. All this can not work without ad hoc telecommunications networks which function independently of any permanent physical infrastructure.

Organizations and institutions rendering international assistance dispose of the telecommunications equipment required for this task, but still today any customs official can - and often will - prevent a team arriving from abroad from importing even a simple walky-talky, not to mention a land mobile satellite terminal. If the equipment nevertheless reaches the disaster site, some official may simply prohibit the use of communications equipment or, as it has happened in the past, arrest its user. Ever since the telegraph was invented, states have, for a number of reasons, aimed at maintaining a monopoly on communications. A license from the respective national authority is inevitably required by anyone who wishes to establish or use private means of radio communications. The present trend to deregulation has in fact made little difference: While many countries even allow other than national enterprises to operate public networks, licenses still have to be requested from a national authority. Such control over public telecommunications networks is, not the least in view of financial implications, understandable, but whenever a disaster requires international assistance, the delay resulting from respective bureaucratic procedures may cost the lives of many who could be saved by an otherwise timely and efficient intervention.

The problem was first officially recognized by an international conference on Disaster Communications (Geneva, 1990), convened by UNDRO, the predecessor of the United Nations Department of Humanitarian Affairs (UN/DHA). While intended as a forum to discuss the applications of the latest telecommunications technology towards disaster mitigation and disaster relief, the conference focused its deliberations and conclusions on the obstacles encountered in their use. Consequently, the 1991 Conference on Emergency Telecommunications in Tampere, Finland, concentrated on this subject and adopted the Tampere Declaration (4), calling upon the telecommunications policy makers to remove all obstacles for the transborder use of equipment. The declaration also called upon the United Nations, to work towards a legal basis for the facilitation of this procedure.

In 1994, the subject was on the agenda of the first World Telecommunication Development Conference (WTDC- 97) of the International Telecommunication Union (ITU) in Buenos Aires, who, in its resolution number 7, urged all member administrations to remove any legal barriers still hindering disaster communications. The Tampere Declaration, so far only a declaration of experts, was annexed to this resolution, thus giving it an official status. Even this ITU resolution is, however, still no legally binding instrument, and its endorsement by the unanimously adopted resolution number 36 of the ITU Plenipotentiary Conference (Kyoto, 1994) did not change this.

As a forum for the efforts towards an effective facilitation of disaster communications, UN/DHA convened in November 1994 the Working Group on Emergency Telecommunications (WGET) (5). It includes all major partners in humanitarian assistance, international and national, governmental and non- governmental organizations, as well as institutions from the telecommunications sector. The WGET has met regularly ever since, and as one of its main activities it has drafted the text for an international "Convention on the Provision of Telecommunications Resources for Disaster Mitigation and Relief Operations".

The draft text for the Convention was, as a follow-up on the Buenos Aires resolution of 1994 on Disaster Communications, first presented at the African Regional Telecommunications Development Conference of the ITU (Abidjan, May 1996). It has since been discussed in a number of major international conferences, namely at the Policy Forum of Americas Telecom (Buenos Aires, June 1996), the Pan Pacific Hazards Conference (Vancouver, July 1996) and the World Aid Forum (Geneva, September 1996). In October 1996 it was presented at the 1996 Annual Conference of the International Institute of Communications (IIC), which has played a key role in the work towards the facilitation of emergency telecommunications ever since the Tampere Conference (6). The convention also received strong support at the first Regional Workshop on Emergency Telecommunication for the Caribbean and Central American Region, organized by UN/DHA (Trinidad, November 1996) and attended by more than 100 emergency managers, telecommunications specialists and representatives of regional organizations and commercial partners from 24 countries. A similar workshop for the Pacific region is envisaged for 1997.

The ITU Secretary-General has circulated the draft convention to all ITU member administrations for comments by the end of December 1996. The document is now ready for a final revision by the drafters and for review by a preparatory conference, and will then be submitted to the "Intergovernmental Conference for the Adoption of the Convention on the Provision of Telecommunication Resources for Disaster Mitigation and Relief Operations", scheduled for 15 - 17 October 1997 in Geneva, hosted by the government of Switzerland.

The adoption of this important document will require the support from the telecommunications policy makers world-wide. In the Pacific region, with its large number of small islands, humanitarian assistance means international assistance -even more so than in most other parts of the world. There can be no doubt, that we can count on the strong support from the countries in this region. This will, however, not happen by itself: At the Intergovernmental Conference in October 1997 the delegates will follow the instructions received from their governments, in most cases from the Ministry of Foreign Affairs. These instructions will be based on the expert advise provided by the national telecommunications authorities.

The Pacific Telecommunications Council's 1997 annual conference is the key forum for the creation of the necessary awareness among the telecommunications policy makers in the region. It is the first major telecommunications event in the so far most important year for emergency telecommunications: 1997 will see the Intergovernmental Conference in Geneva, and in anticipation of this major event, the ITU council has chosen "Telecommunication for Humanitarian Assistance" as the motto for World Telecommunication Day (17 May). The developments expected for 1997 will finally make it possible to ensure the full application of telecommunications to the most noble of causes:

The prevention, and, where this is not possible, the alleviation of human suffering caused by disasters.

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Biographical note: Hans Zimmermann is Senior Humanitarian Affairs Officer, responsible for the co-ordination of international humanitarian assistance and in charge of emergency telecommunications. He frequently represents the humanitarian community and in particular the United Nations in major international conferences and he regularly writes for publications on humanitarian affairs and telecommunications. Mr. Zimmermann's earlier assignments include longer term posts in countries affected by humanitarian crises such as Lebanon, Pakistan, Ethiopia, Afghanistan, Iran and Liberia and numerous missions to sites of natural disasters. Mr. Zimmermann is a Swiss national, and his academic background is in political science.

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VSAT APPLICATIONS ADVANCE AS ASIA LIBERALIZES

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ABSTRACT

The liberalization of the telecommunications sector in developing countries has proven to be the catalytic force driving the introduction of new technologies. This paper will examine the way in which aggressive private-sector companies building VSAT networks to serve the sophisticated data and voice needs of corporate customers have gained prominence in emerging-country telecommunications markets.

INTRODUCTION

The liberalization of the telecommunications sector in developing countries has proven to be the catalytic force driving the introduction of new technologies. Newly licensed private operators have been among the first companies to implement new technologies. Placed in a competitive environment, these operators strive to install technologies that are rapidly deployable and offer significant cost savings over traditional terrestrial telecommunications networks.

This paper will examine the way in which aggressive private-sector companies building VSAT networks to serve the sophisticated data and voice needs of corporate customers have gained prominence in emerging-country telecommunications markets. In most of Asia, international and domestic telecommunications networks are far from sufficient to meet corporate needs; companies may lease international circuits from local carriers or build their own private international networks, but the former option often means unreliable service, while the latter is both costly and time-consuming. These operators offer an alternative to the often unreliable and inadequate state-owned data communications facilities, by providing dependable and efficient services with speeds up to 64 Kbps, and interconnecting dispersed user sites without PTT bureaucracy.

The paper will focus on three specific country examples that highlight these trends across examples of key markets in South Asia, East Asia and Southeast Asia.

In Asia, while much of the growth in the past few years has occurred in Southeast Asia, particularly Thailand, Indonesia, and the Philippines, these markets are expected to be dwarfed by the emergence of India and China, where new operators are now building out networks fiercely.

VSAT OPERATORS TO LEAD THE WAY IN INDIA

During the 1980s, a severe shortage of investment limited the DoT's ability to serve the nation's big business communications users with reliable, nationwide network services. Given the dearth of leased lines available from the DoT and the long waiting periods, as well as an unreliable, low-capacity and slow public datacom network, many companies resorted to setting up their own dedicated networks. Foreign operators had been scouting the Indian datacom landscape for decades, but their efforts to bypass the DoT were stymied politically, while efforts to develop services over the DoT's network were hampered by poor quality of data transmission.

In India, deregulation of the telecommunications industry has brought immediate and tangible benefits to the public. India's national telecommunications operator, the Department of Telecommunications' (DoT) inadequate telecommunications services and facilities did little to serve the needs of the corporate community that was hungry for reliable data communications. In 1992, the DoT announced its decision to liberalize the country's VSAT market — a decision that sent companies scurrying to fill a much needed market niche.
In India, the demand for datacom services has risen dramatically in the past two to three years, largely due to the surge in foreign companies setting up local establishments that need to stay in constant communication with their head offices abroad. Demand has also come from local companies looking for reliable and efficient datacom services.

The DoT licensed seven operators all of whom have chosen to offer data communications services over shared hub VSAT technology, and to date, have invested close to $80 million in their networks. One vendor estimates India's VSAT services market will grow $150 million per year over the next five years, with the VSAT equipment market reaching $1 billion by 1999.

With private VSAT operators rushing in to fill the void, the DoT is also scrambling to install its own high-speed datacom network. As commercial availability of modern datacom facilities spreads, private investment is expected to shift from dedicated datacom network infrastructure to equipment and products that will facilitate access to public network infrastructure and emerging alternative service providers.

The seven VSAT operators include Hughes-Escorts Company Ltd. (HECL), the first company to sign a formal license with the DoT in August 1994 the first operator to cut over VSAT services in India in February 1995, Comnet Systems and Services Ltd., Comsat-Max Private Ltd. (CMPL), the RPG Group, Wipro Infotech, Amadeus, a joint venture made up of Australian operator Telstra International (40%), Indian carrier Videsh Sanchar Nigam, or VSNL (20%), and India's Infrastructure Leasing and Financial Services Ltd. (ILFS), and Himachal Futuristic Communications Ltd. (HFCL).

Demand for VSAT services is expected to remain strong as India's economy continues to grow. And as alternative data communications facilities are limited to the country's two public packet switched data networks — the DoT's I-NET and VSNL's international GPSS network --there is no question that there is room for several shared hub VSAT services providers to profit from the pent-up data communications demand during the next few years.

NEW COMPETITORS TO SHAKE UP SOUTHEAST ASIA

With new technology, including lower-cost terminals that offer features, such as video compression, a new cast of VSAT operators is poised to compete in Southeast Asia. In Thailand, two new VSAT operators are preparing to implement new-generation VSAT technology to provide low-cost videoconferencing services. Siam Videoconferencing Co., a joint venture made up of Loxley (40%), Siam TV & Communication (40%), and Siam Sat Network (20%), plans to offer videoconferencing over a combined VSAT and fiber optic network.

A second new operator, Telesat, was recently licensed to build and operate a VSAT-based information superhighway. Telesat is owned jointly by a number of partners including Sahaviriya OA (49%), Thai Farmers Bank (25%), Itochu Thailand (5%), and Acer International (5%). The two new operators paid more than US$81.4 million (2 billion baht) apiece in exchange for 22-year concessions from CAT.

The newly licensed operators join three players that have already set up VSAT networks with several hundred remotes apiece for commercial data communications. Compunet, a joint venture between C&W and two local firms, operates a dual-hub VSAT network for dedicated SCPC/MCPC data transport and protocol emulation. The company has a 15-year build-operate-transfer (BOT) agreement and returns 5% of its revenues to the Posts & Telecommunications Department. Compunet expects to expand its network by at least 100 remotes annually during the next several years. Samart Telecommunications 40% owned by Australian carrier Telstra operates a distributed-hub VSAT network that offers SCPC and MCPC data transport, E-mail, database access, and EFT/POS services. Acumen ISBN offers point-to-point and point-to-multipoint transmission over its VSAT network to third-party clients.

THE PHILIPPINES LOOKS TO VSAT NETWORKS FOR BUSINESS AND RURAL NEEDS

The Philippines' geography — with over 7,100 islands — makes satellite technology a viable option in reducing obstacles to serve remote and rural areas as well as providing the optimal solution to business needs. In addition, the increasing demand of the private sector for data communications services indicates there is a strong growth potential for VSAT-based services. The Philippine government's National Information Technology Plan 2000 targets the installation of a national information super highway for data exchange running through commercial carrier facilities that use VSAT networks. The rapid growth of the banking and financial sectors, both of which are the main subscribers to VSAT services, will also boost the demand for these services.

Also in the pipeline are plans to launch the country's own satellite in December 1996. This will bring down substantially the cost of operating a VSAT network as a large portion of the high cost of VSAT services can be attributed to the cost of leasing an INTELSAT transponder, making the services more popular.

On the public network side, the government has made rural telephony a priority for the next three years. Also, the government plans to install a public call office in each municipality. Given the geography of the country, VSAT-based applications may prove to be the ideal way in which to address these goals.

VSAT NETWORKS FLOURISH IN CHINA

The People's Republic of China is well on its way to becoming one of Asia's largest market for VSAT networks. While several years ago, VSATs in most of China's networks fell into the tens, as of December 1995, the Ministry of Posts & Telecommunications (MPT) reported the number of VSATs installed stood at 3,000, with nearly twice that many on order. China's changing VSAT landscape has been spurred by the country's liberalization measures; the country now boasts 14 data communications services carriers.

The vast majority of VSAT networks operating in China use the C-band frequency for transmission, although Ku-band networks are gradually becoming more common. Satellites covering China include the MPT's two Dong Fang Hong-8 C-band satellites and the ChinaSat-5 satellite. The AsiaSat and APStar satellites are also permitted to lease transponder space to Chinese VSAT customers. Annual leasing costs average between $1.4 million and $1.6 million per transponder.

The Ministry of Posts & Telecommunications (MPT) still operates one of the largest shared hub networks, through its subsidiary, China Telecommunications and Broadcast Satellite Corporation (ChinaSat), which manages the MPTs space segment. ChinaSat's V-Net provides voice and data communications for ChinaSat and several other customers, including airline holding company CAAC and Chinas Seismic Bureau. V-Net has more than 300 remotes in service.

Non-MPT shared hub network operators fall into two categories — organizations that built VSAT networks primarily for their own use and then leased capacity to others, and organizations that built networks primarily to offer shared hub service. China Investment and Trust Corporation (CITIC) operates a hub that supports 33 data transmission VSATs for its own use and offers shared hub service for third-party networks. Other state-owned, private networks that have spawned shared hub services include China National Petroleum & Chemical Co., which plans to grow its network to 2,000 VSATs by 1997, and the Peoples Daily, Chinas main newspaper, which plans to offer its VSAT transmission and value-added services (VAS) to other news organizations around the country.

One of the most recent entrants into the market, JiTong, though licensed in September 1993, formally registered in January 1994, and began work on its plans for a nationwide data communications infrastructure. JiTong's mandate is to establish a national "Information Super-Highway" to facilitate economic activities throughout China by building an effective national network of data communications. At the heart of JiTong's activities is the Golden Bridge network — a VSAT-based ISDN backbone, with platforms supporting E-mail and electronic data interchange (EDI) at speeds ranging from 144 Kbps to 2 Mbps. The operator will be providing services such as the management of quota permits, foreign exchange collection and clearing, export tax refunds, management of import/export statistics, an EDI system that will create a platform for paperless" trade, a nationwide credit and banking card network over VSAT technology.

A few big players in Chinas shared hub VSAT market are specialized organizations that built networks primarily to offer shared-hub service. In coastal Guangdong Province, Guangzhou Satellite and Guangzhou Tesonics both operate data networks with several hundred VSATs apiece. Shanghai Sat and ShangSat operate networks of 300 and 120 remote voice and data terminals, respectively.

Liberalization has resulted in attracting the attention of an increasing number of global operators and satellite equipment vendors. Also, it has made possible the introduction of advanced business services by unlocking a new market for satellite communications equipment and services which was virtually non-existent in emerging markets until a few years ago.

Multimedia VSATs
Innovative Uses of DirecPC™ and VSAT

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Abstract

Corporate networks are undergoing a revolution. They are being tasked to provide efficient, secure, high-performance multimedia information access. Regional and remote offices want to connect to headquarters as well as to other information centers and access up-to-the-minute information, but the speed at which they obtain information can often pose a problem. Until now, a large file or document could take hours to transmit, tying up important computer and communications resources, and, more importantly, making it difficult to locate and use information in an increasingly competitive environment.

Now, with the introduction of the Multimedia VSAT - the merging of the DirecPC service with a very small aperture terminal (VSAT) - a multitude of applications can be made far more efficient and cost-effective. This, in turn, will allow many companies and their remote offices to provide superior sales and service to their customers through enhanced training and business television applications. Using existing, industry-standard Internet technology, corporate intranets can support new applications such as interactive technician's manuals, service bulletins, and numerous databases. New marketing tools such as virtual showrooms and interactive catalogs can be developed to promote the company's products to customers at sales outlets and on the Internet.

The purpose of this paper is to provide an overview of DirecPC and VSAT technology and demonstrate their applicability to corporate networks as an integrated Multimedia VSAT system.

1. INTRODUCTION TO VSATs AND DirecPC

The application of HNS' Personal Earth Station™ (PES™) VSATs to corporate networks is not a new concept. Many of the world's leading companies have been operating these networks for years with substantial increases in performance, while simultaneously reducing costs. VSATs are being used to support a wide array of corporate applications, including:

- Financial reporting/sales information transfers
- Orders and shipment information transfers
- Credit verification
- Inventory management
- Customer histories and warranty information
- Online maintenance assistance
- Backup links to factory locations
- Gateways into public packet networks
- Corporate local area network (LAN) access

VSATs are an especially good fit for any company with the need for effective communications between headquarters and a large, distributed remote office population such as banking, finance, insurance, automotive, retail, etc. VSAT technology has proven to be effective in ensuring a high level of secure communications between headquarters and remote offices, thereby improving the level of sales and service these offices can provide for their customers.

However, with the introduction of DirecPC, innovatively minded companies are exploring the power of the DirecPC/VSAT combination to achieve improved customer satisfaction and greater efficiencies, while continuing to reduce costs. DirecPC adds the capability to transmit data at very high speeds - typically using a 12 Mbps outbound carrier. It offers high-rate access to the global Internet or corporate intranets, Motion Picture Experts Group (MPEG) quality broadcast video, and high-speed distribution of large data files to multiple sites simultaneously.

By combining these DirecPC features with the existing capabilities of the VSAT, we create the *Multimedia VSAT*, an industry first. A company can use the Multimedia VSAT to meet its communications requirements more efficiently than ever before. Additionally, new, exciting, interactive applications not possible before can be developed to promote sales and enhance customer service.

System Connectivity

A diagram illustrating the connectivity of the Multimedia VSAT along with standard PES and DirecPC remote sites is shown in *Figure 1, Multimedia VSAT System Connectivity*. A complete network may include any combination of the three types, depending on the application requirements at each site.

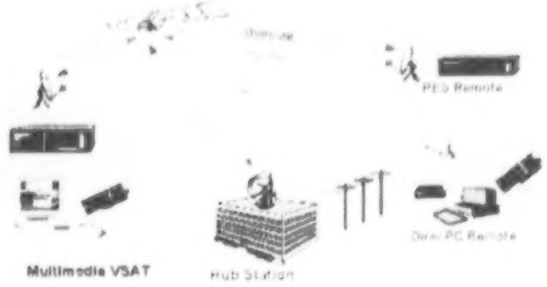
PES Remote
Multimedia VSAT
Hub Station
DirecPC Remote

Figure 1. Multimedia VSAT System Connectivity

The hub station is shown as a single site providing both the DirecPC NOC and the Integrated Satellite Business Network™ (ISBN™) hub. It is also possible for a network to have these two uplink facilities at different geographical locations. Combinations of different transponders, different satellites, etc., may be possible; however, those situations will not be addressed by this paper. This discussion assumes that the same satellite and transponder are used for both outbound carriers and uplinked from a single location.

PES Remote

The *PES Remote* in *Figure 1* communicates with devices attached to the hub station through the inroute and outroute carriers in the ISBN network. The interfacility link (IFL) cable is connected from the antenna to the PES indoor unit. Data requests are sent via the inroute (64, 128, or 256 kbps), while the return data is sent across the 512 kbps outroute.

DirecPC Remote

The *DirecPC Remote* in *Figure 1* relies on a dial-up modem for inbound access. The IFL cable from the antenna is connected directly to the DirecPC adapter card in the intermedia server PC. When an application at the dealer site generates a data request, the DirecPC system dials the modem and connects to the hub station. The requested information is then sent to the remote site through the high-speed 12 Mbps carrier.

Multimedia VSAT

The complete *Multimedia VSAT Remote* shown in *Figure 1* provides the best overall high performance package. A *single antenna* is connected to the PES indoor unit via the IFL cable. The intermedia server PC's adapter card is connected to the video port on the PES. This port provides the full L-band spectrum from which the DirecPC adapter card extracts and demultiplexes the high-speed carrier. In this configuration, all inbound traffic is sent via the PES inroute. Depending on the destination of the request packet, the return data will arrive through the PES outroute or the DirecPC high-speed carrier.

Features and Capabilities

The Multimedia VSAT is capable of supporting various applications, as demonstrated in *Figure 2, Multimedia VSAT Capabilities*. Using a single remote antenna, it can receive MPEG-quality video and support two-way LAN and serial data traffic, as well as voice and fax communications. Internet access can be provided using industry standard software tools via an Internet gateway link at the hub station. Intranet applications can be developed to take advantage of those same Internet software tools for internal information needs. It is possible to offer interactive training sessions and broadcast business television to any remote site. The system can also be used to improve sales. As an example, an automotive dealer's showroom could include a *virtual showroom* that interactively allows a customer to learn about the dealer's products that are not currently on the lot.

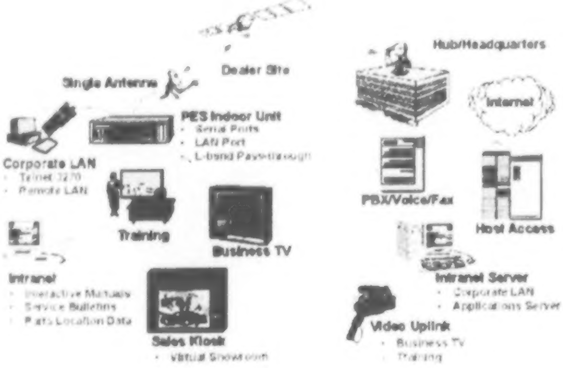
Dealer Site
Single Antenna
Hub/Headquarters
Internet
PES Indoor Unit
• Serial Ports
• LAN Port
• L-band Pass-through
Corporate LAN
• Telnet 3270
• Remote LAN
Training
Business TV
PBX/Voice/Fax
Host Access
Intranet
• Interactive Manuals
• Service Bulletins
• Parts Location Data
Sales Kiosk
• Virtual Showroom
Intranet Server
• Corporate LAN
• Applications Server
Video Uplink
• Business TV
• Training

Figure 2. Multimedia VSAT Capabilities

The PES VSAT portion can be used for LAN connectivity to the corporate office, as well as support for serial data traffic to a central host processor. The DirecPC portion provides business television, package delivery, and Internet access. The high-speed carrier also permits delivery of large data files to remote sites.

The DirecPC computer becomes a *mixed media* server when installed with Starlight Networks StarWorks™ software, which manages the delivery, bandwidth reservation, and server storage functions required to distribute the incoming multimedia data to users on the network, as shown in *Figure 3, InterMedia Network*. The incoming broadcast can be distributed immediately or stored for later retrieval, which is advantageous where files do not need to be delivered in real time. Instead, information can be transmitted at a lower bandwidth over a longer time at nonpeak times for lower cost. The mixed media server not only receives transmissions from the DirecPC services, but it manages the delivery of InterMedia information to users on the network from other sources as well; for example, from a Lotus Notes server, Internet server, intranet server, multimedia server, etc. These enhanced capabilities are extensions of the basic DirecPC services:

- Multimedia video broadcast
- Digital/multimedia package delivery
- Turbo internet/intranet access
- Access security control

Multimedia Video Broadcast

DirecPC offers multimedia broadcasts as a one-way packet transmission in a data-pipe format for video, audio, or regularly transmitted information that is scheduled. This service is available to a selected group or all of the information provider's locations. A conditional access mechanism ensures that a receiver may access only that data which the network operation center (NOC) management has authorized it individually to receive. The transmission schedule can be selected to meet the needs of the organization.

Digital/Multimedia Package Delivery

DirecPC *Package Delivery* service provides one-way broadcast of digital video, audio, or text-based files such as software, computer-based training, documents, or any other content from a publisher to any number of locations. The broadcast can be either scheduled or on demand. The information provider forwards the digital information with its envelope of address and scheduling to the NOC. The transmission rate may be set per package, up to 3 Mbps.

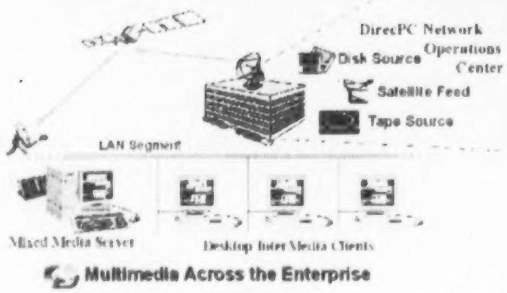
DirecPC Network Operations Center
Disk Source
Satellite Feed
Tape Source
LAN Segment
Mixed Media Server
Desktop InterMedia Clients
Multimedia Across the Enterprise

Figure 3. InterMedia Network

Turbo Internet/Intranet Access

Turbo Internet access allows PCs to be connected to the Internet via the NOC. The NOC is connected to an internet access provider (IAP) by terrestrial line. Inquiries to the Internet in the inbound direction are sent over the PES inroute to the NOC. Outbound information is then sent to the dealer site via the DirecPC carrier. The user may receive information from the Internet, up to 400 kbps, because the NOC spoofs the IAP and provides a larger, more effective transmission control protocol (TCP) window size. Intranet access is handled similarly; however, the host now resides on the corporate LAN instead of the public Internet.

Access Security

The content transmitted over DirecPC is protected against access by other users by providing each content publisher with its own account within the NOC. Billing and other statistics that are available from the system are accessible by the publisher. Users can be blocked from receiving certain packages or from using other DirecPC services based on configuration and conditional access control from the NOC. The NOC architecture is scalable to support as many publishers as required.

Multimedia VSAT

The key feature of the Multimedia VSAT is its ability to share optimally both DirecPC and PES communications resources. Serial data from a host processor, for example, could be serviced by the outroute using the serial ports on the PES indoor unit. Corporate LAN connections can be made using either outbound access method, depending on the application. Interactive applications make use of both high performance data channels.

The Multimedia VSAT also helps to streamline existing applications that rely on CD-ROM technology, as illustrated in *Figure 4, Dynamic Content Transport*. Static data that does not change frequently can continue to be shipped to dealers on CD-ROM. As the need to update the data increases to weekly, daily, or real-time updates, DirecPC's package delivery service can be used to either supplement or replace the CD-ROM distribution method.

This service allows for an optimal combination of distribution methods because certain applications may not require the added Multimedia VSAT features.

In order to provide good customer service and stimulate sales, remote locations must be well educated about the organization's products and service capabilities. The Multimedia VSAT enables improved quality training techniques as well as business television applications. It makes new intranet applications possible across the enterprise network and allows virtual showrooms to be created.

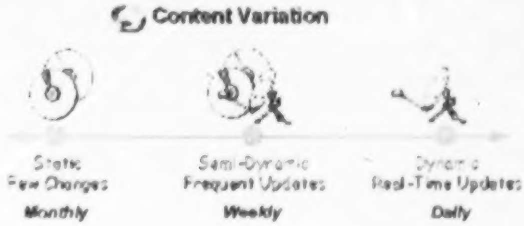

Figure 4. Dynamic Content Transport

2. CORPORATE APPLICATIONS

Corporate Communications (The Intranet)

Large corporations have many local LANs across their locations and often desire to link these LANs into a larger network. When these networks combine different LANs into an openly accessible network, it is often referred to as an internetwork, or *internet*. The global Internet is an example. However, for many reasons it may not be desirable for a corporation to interconnect its networks using the global Internet or as an open network with access to other outside networks. A private, corporate system that does not have access to networks outside the corporate environment is known as an *intranet*. Intranets allow you to create interactive applications by taking advantage of the same technologies and tools used to create Internet content and applications.

Companies in many industries are finding that Internet and World Wide Web technology is an excellent way of distributing information within their organizations. Intranets allow corporate users to search for and access any type of data in an easy to organize form. Some companies are integrating their intranets with existing business functions. U S WEST, for example, will soon be able to service customer requests, such as expanded phone service, through their web browsers. By linking their intranets to the Internet through secure gateways, Federal Express allows Internet users to track their packages with their web browsers. Employees at many corporations who have no programming experience can quickly add information to internal databases linked to the intranet. Information can be distributed far easier than before. Securities companies are using global intranets to continually update financial statistics as they change where previously they would have to send data on a delayed basis, often one day late. Morgan Stanley has also connected a global messaging system to its intranet so that any messages that would have gone unheard if the person walked away from the speaker are now digitally recorded on a PC through a web browser application. If someone missed a message, he or she can simply have the web browser play it back.

The intranet allows an automotive corporation to develop many distributed and client/server applications allowing dealer sites to be more productive and service their customers' needs more effectively. The intranet, based on HNS' Multimedia VSAT, combines the high-speed receive features of DirecPC with the transmit/receive performance of the PES remote. An intranet user's requests are transmitted to the hub server via the PES inroute, while the return data is sent via the high-speed DirecPC carrier. As the user's requests will consist of small packets, while the return data may be as large as a full-motion video clip, this system provides optimal asymmetric connectivity.

Interactive Technicians' Manuals and Service Bulletins

Technicians' manuals and other service department related documents are typically provided in a printed manual or through a computer-based system. The computer-based system may be as simple as microfiche readers used by a technician to see a picture of how a particular component fits into the system and includes a complete component list. A more sophisticated computer system uses CD-ROM technology, allowing the technician to see the picture and a set of instructions on a computer screen. The CD-ROM software may also provide the ability to search through all of the service manual's topics using a keyword such as the name of a part or component.

Microfiche readers provide limited functionality and do not provide the technician with an easy-to-use, intuitive interface to the information. The technician must first determine which microfiche to use by searching through an index that typically is a printed document. CD-ROM systems have the disadvantage that a new CD-ROM must be created each time the information is updated, necessitating a new shipment to each remote site. This solution, although more robust than a microfiche reader, is suited for static content and is not effective for applications where content changes frequently.

The Internet uses a document format known as HyperText Markup Language, or *HTML*, on the World Wide Web. The Web is a graphical method of "browsing" the content of the Internet. The same technology can be applied to any

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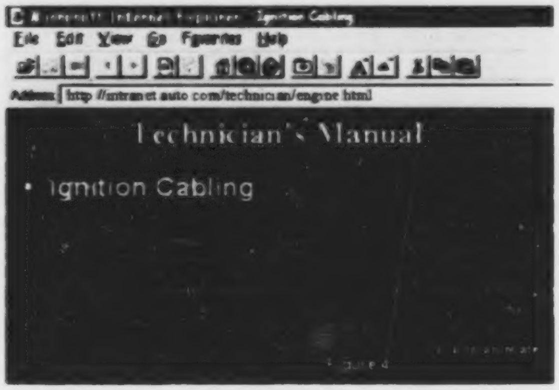
company's intranet. This is a very flexible technology that allows a user to view and search through a series of documents using a simple graphical point-and-click software interface. The user can employ any existing Web browser software to view the technician's manual. *Figure 5, Technician's Manual* shows an example automotive service manual viewed within a Web browser.


Microsoft Internet Explorer - Ignition Cabling
File Edit View Go Favorites Help
Address

http://intranet.auto.com/technician/engine.html

Technician's Manual

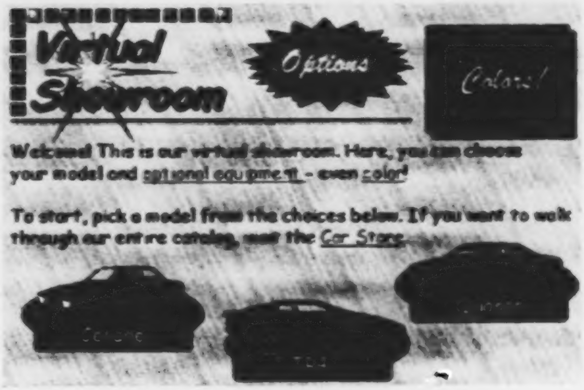
- Ignition Cabling

Figure 5. Technician's Manual

The Multimedia VSAT provides all dealer sites with this online, interactive technical manual in a cost-effective, efficient way. The broadcast nature of a satellite network makes it possible to locate the technical manual files on an intranet server connected to the hub station, while making it immediately available to any and/or all dealer sites. There is no longer any need to ship any storage media to dealer sites while still providing an advanced and flexible application. Video and animation as well as audio can be used to enhance the technical manual. All of the data is transmitted to the dealer site and to the technician's computer via real-time file transfers without requiring the entire application to exist on the local computer. The Multimedia VSAT makes all these features possible.

Interactive Multimedia Sales Tool

In an increasingly competitive market, manufacturers must continue to find new, innovative methods of marketing their products to consumers. The popularity of the Internet has made "online" marketing an essential component of every manufacturer's set of marketing and sales tools. Organizations in many industries have discovered the concept of online catalogs and sales brochures that help entice potential customers into buying their products. For auto manufacturers, this concept has been realized in the form of the *virtual showroom*. The virtual showroom is an interactive method for auto manufacturers to show their products to consumers, both on the Internet and in the dealer's showroom itself. *Figure 6, Virtual Showroom Application*, shows what one might look like. Other industries may want to provide a virtual catalog or some other method of advertising. Placed in the dealer's showroom, a kiosk PC running this application would allow the customer to view pictures of the car they are interested in and to select options packages and exterior/interior color combinations. The virtual showroom functions similarly to the interactive technician's manual with "links" to other sections of the application. The entire application itself might exist as another intranet application or stand alone. It could be used by the salesperson to show a customer a car the dealer does not currently have in stock; a situation that would have resulted in a lost sale now could become a completed sale. Furthermore, this showroom could be used for car auctions of used cars as well as for new car sales.



Welcome! This is our virtual showroom. Here, you can choose your model and optional equipment - even color!

To start, pick a model from the choices below. If you want to walk through our entire catalog, visit the Car Store.

Figure 6. Virtual Showroom Application

The Multimedia VSAT not only makes this application possible, but it also enhances it in ways no other technology can. Where simple pictures of the car could be shown on a standard VSAT solution, the Multimedia VSAT provides the capacity for full motion-video clips as well as audio. The kiosk PC itself does not require large storage space because the information could be transmitted in real time as the application is accessed and cached locally by the PC for future use to reduce transmission time. The Multimedia VSAT gives customers a fully interactive experience in selecting their new or used car.

Business Television and Distance Learning

Business Television is used for video programming to branch offices for purposes such as training, distance learning, or corporate video broadcasts. A large corporation would use Business Television for distributing video programming to remote sales offices. This programming could be advertising material used in the showroom or live corporate management presentations to all employees, whether they are located locally or remotely. Distance learning provides lessons or lectures from one site to a potentially large number of remote locations. Manufacturers rely on distance learning technologies to keep their service technicians trained and keep their sales staff knowledgeable about the latest features in their products. The Multimedia VSAT enhances traditional distance learning implementations through the use of the InterMedia server and its other services.

Broadcasting video, whether real-time or file-based, is a fundamental feature of the Multimedia VSAT. By using the high-speed carrier of the DirecPC system, high-quality MPEG video can be broadcast to any selected number of remotes simultaneously and securely, thanks to the conditional access system. This video data stream can be displayed on computer screens across the LAN and on TV monitors, or stored to disk or tape for later viewing at each remote site. Because the Multimedia VSAT system provides these video capabilities along with so many other unique services, it is a cost-effective method for delivery of business television and distance learning as compared to traditional broadcast video solutions.

The DirecPC intermedia server distributes the video to each PC in the LAN or to video monitors in the classroom. It is possible to have students in separate rooms or in a single classroom because all of them are linked by the LAN to the intermedia server. Each PC contains SoftPad™ software from ONE TOUCH™ Systems that can receive questions from the instructor, who is located at or connected to the hub station. Every student can respond to questions through his or her PC. The instructor could use the capabilities of the PC itself to enhance their training session. The power of the Multimedia VSAT system is that all the components needed to use distance learning are already in place when used for the other applications discussed in this paper. Traditional networks would require separate broadcast video equipment as well as special site controller hardware and student keypads to provide the same functionality.

Internet Access

The Internet is a vast system of interconnected networks that contains increasingly valuable information. Information ranging from popular interests, such as sports and leisure, to technical material, such as product information from manufacturers, is being placed on the Internet for anyone to access. The Internet has become a valuable source of research information that more and more companies are finding useful to their everyday business. Corporations have found the Internet to be both a strategic marketing tool to present information to potential customers and a useful tool for research.

Internet access can be broken into two types: *server access* and *client access*. Server access involves connecting a computer server to the Internet for *other users* to see *your* information while client access refers to *your* ability to see information *already available* on the Internet. The Multimedia VSAT system offers optimal access to both types through various connectivity combinations. An automotive corporation might be interested in giving its dealer locations and regional offices client access to the Internet as a research tool. An example of this might be to see what competing automotives are marketing on the Internet. An automotive corporation may also wish to place its own server on the Internet to advertise its products through a virtual showroom and to survey potential customers for market research.

Server Access - Publishing on the Internet

In the U.S.A., Internet advertising is increasingly used by all companies. When a corporation wishes to advertise on the Internet and use the Internet as a marketing tool, it is necessary to connect a server to the Internet. *Figure 7, Publishing on the Internet*, demonstrates how this can be done using the shared hub station facilities of the Multimedia VSAT network. This approach uses the hub's existing high-speed link to the Internet.

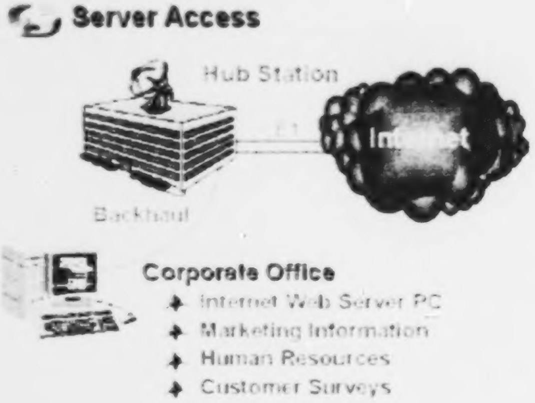


Figure 7. Publishing on the Internet

Using a backhaul connection to the corporation's Internet server, other users on the Internet can view marketing information about the company's products. The Interactive Multimedia Sales Tools described earlier could be made available to all Internet users, providing them with a virtual showroom or catalog. In addition to advertising, the corporation might also conduct surveys of the users visiting their web page. This could be used as a market research tool. These are only examples of the many benefits a corporation will achieve by publishing a web page on the Internet. Any applications developed for the intranet can be connected to the Internet server for customer access. This is similar to Federal Express connecting their intranet databases to the Internet, allowing customers to track their packages.

Client Access for Corporate Users

Using the full potential of the Multimedia VSAT client access is achieved by combining the PES inroute for transmitting data requests and the high-speed DirecPC outbound carrier for receiving data from the Internet server. This is shown in *Figure 8. Turbo Internet Access*. The Multimedia VSAT technique operates in the same fashion as a corporation's intranet access. The only difference is that the web server is located somewhere in the Internet, instead of on the corporate LAN as in the intranet. This method best serves remote sites that frequently use the Internet and require the best performance possible for that access as well as requiring two-way data communications to the corporate LAN or intranet.

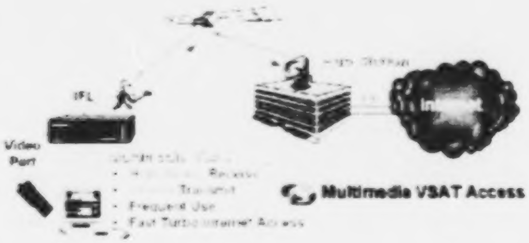


Figure 8. Turbo Internet Access

3. CONCLUSIONS

Corporations today are faced with the challenge of how to incorporate the onslaught of new mixed media datatypes such as audio, video, animation, graphics, text, databases, word processing, document applications, and new multimedia-based applications that incorporate audio and video; collaborative applications including groupware, file sharing, and Internet; and intranet services within their current Information Technology infrastructure. The technology that enables this collaborative, interactive environment and makes it available to users in a cost-effective way throughout the enterprise, over corporate networks, intranets and wide area networks, is the *Multimedia VSAT*. This new technology will allow corporations to better service their customers and better support their sales and marketing efforts.

VSATs in China: Technology, Applications and Growth Prospects

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Overview

Small terminal based systems or VSAT, mostly SCPC and TDM/TDMA began in China in 1988. The official news agency, Xinhua was the first customer to use VSATs for transmitting wire reports to its local bureaus. Soon after, **ChinaSat**, a public service provider under the Ministry of Posts & Telecommunications (MPT) also deployed a VSAT network for customers including civil aviation, customs administration, and seismological survey. During this period, development in transmission efficiency (datarate and throughput), access scheme, and network management was still crude, and the cost of equipment was high. Also during this time, demand for VSAT service was low and largely concentrated in a small group of users who were engaged in time critical businesses. Information distribution service was still in its infancy.

The VSAT market changed quickly in the early 90s due to two developments. First, a new policy was initiated that satellite communications, along with fiber optic cable and digital microwave, should be developed as the primary transmission media for PSTN replacing copper and coaxial cables which were becoming serious "bottlenecks" for the increasing switching capacity and voice/data traffic. Satellite communications was given top priority as an effective solution to China's vast geography and dispersed population in remote areas. The new policy resulted in vigorous growth in satellite communications, both in Intelsat standard networks (for trunk traffic and interconnection with PSTN) and VSATs. CTR Group estimates that by the end of 1995, the total market value of satellite market in China was at $1.5 billion (including satellites, launching, Intelsat standard stations, VSATs and TT&C stations). The total size of VSAT market (installed and contracted) was about 5,500 stations, in which 800 for voice service (mostly private networks), 1,200 for interactive data and 3,500 for broadcast systems, i.e., data, audio and paging services. Television receive only is primarily analog and is not included in the VSAT market.

Meanwhile, VSAT technology continued to improve with better design, increased performance and lower costs. VSATs have become a favorite alternative for government and corporate communications to terrestrial networks with long deployment time and cost of leased lines is high.

Today, China's VSAT market is deregulated and one of the most competitive industry sectors, especially in equipment sales. There are no restrictions from the MPT on VSAT sales, as long as standard technical specifications are complied to. Foreign equipment suppliers can sell directly in China with little regulatory barriers. The service market, on the other hand, has been open to domestic competition since 1993, and non-MPT companies can provide public VSAT service by licensing from the MPT. By far 17 domestic companies have obtained licenses, and majority of them are engaged in information distribution business such as data broadcast and paging. Despite its competitive nature, growth of interactive VSAT services has been slow with few customers signing up and, as the result, some VSAT companies are having difficulty maintaining operations. VSAT service market is open to Chinese operators only, foreign companies are prohibited from entering the service market.

VSAT Networks

VSAT systems in China are essentially used for three types of services: 1) voice and interactive data; 2) one-way information distribution; and 3) satellite feed cable TV distribution programming.

The predominant architecture for voice is **SCPC/DAMA** (single channel per carrier/demand assigned multiple access). The technology dictates a mesh network topology in which every remote site in a network communicates with any other site and the hub; the hub sets up channels for two sites on demand for connection and priority basis so that the network can achieve much higher efficiency for links and transponder time. With improved processing power and algorithm for voice compression, today's SCPC/ DAMA systems can provide near toll voice quality and relatively short lapse for channel setup and teardown.

Satellite voice network experienced a booming period during 1991-94 in China, when Hughes Network Systems began to sell its TES systems, including ChinaSat and China National Coal Corp. Scientific-Atlanta has also supplied an SCPC/DAMA network to NORINCO, a defense conglomerate. Other companies have provided alternative technologies for voice and data communications, typically MCPC (multiple channels per carrier) and variation of TDMA (time-division multiple access) for smaller size networks and heavy traffic, including Spar/ComStream, NEC and Satellite Transmission Systems (STS).

The main reason for the growth of VSAT voice networks in China was inadequate PSTN infrastructure that could not keep up with demand for private communications. In the early 1990s, national telephone density was only 1.1 per 100 people, and the average waiting period was 1-2 years for line installation. Many large users, especially industries with multiple operations in multiple locations and high scale of integration decided to deploy private networks to alleviate communications pressure and accommodate rapid growth. VSAT system was chosen for its short deployment time, instant connection, and comparable performance. Foreign companies like Hughes Network Systems were able to cash in for the strong demand and strengthen their market position.

However, deployment of VSATs for voice communications has slowed down since 1995 both in number of contracts and size of networks, as the result of rapid development in PSTN, PCM quality of voice, and savings in in-house engineers and maintenance. In response to the change, VSAT market has shifted to data communications and integrated services in which VSATs have unique advantages over terrestrial networks, such as share of outbound stream hence a savings in space segment, remote area access, and distance insensitive.

At present, interactive data networks represent a main front in satellite communications market in China. Different from SCPC networks which usually use mesh configuration for remote-to-remote connectivity, a typical VSAT network uses star configuration, in which the hub sends continuous data stream to all remotes (typically with time division multiplexing or TDM), whereas each remote site sends data in bursts to the hub at assigned time slot, or called time-division multiple access (TDMA). In a **TDM/TDMA** environment, most data traffic is between hub and remotes, a desirable configuration for applications of processing transaction data at banks, or survey information collected from oil drilling fields to the headquarters for analysis.

The initial expectation was that once VSAT market was decentralized, non-MPT companies would wage strong competition by taking away VSAT customers from the MPT. However, after more than three years, this imaginary competitive environment has yet to become a reality. On the contrary, most VSATs in China are private networks, this explains the strong surge in acquiring private VSAT networks during the early 1990s. Shared hub service is rare due to concerns of organizational structure, service availability, pricing, technical competence, and maintenance. By 1996 there are about 70 VSAT networks operating on about 5,500 stations (including broadcast networks), or an average of less than 80 sites per network (the number of sites are much lower if data broadcast networks are excluded). The problem of under utilization will continue to be the major constraint in sustained growth, and it indicates the market is entering a mature phase in technology, application and competition after years of strong growth. Figure 1 lists the largest VSAT networks in China.

Figure 1

Largest VSAT Networks in China
(By November 1996)

Customer	Application	Time of Operation[1]
Beijing Posts & Telecom Admin.	Data	1989
Ministry of Petroleum	Data/Voice	1990
People's Daily	Data	1991
People's Bank of China	Data	1993
ChinaSat	Data	1993
National Meteorological Bureau	Data/Voice	1994
China Aviation Admin.	Data/Voice	1994
Xinhua News Agency	Data/Voice	1994
Shenzhen Stock Exchange	Data; Data Broadcast	1994
Shanghai Stock Exchange	Data; Data Broadcast	1994
Shanghai VSAT Co.	Data	1994
North Industry Corp.(NORINCO)	Voice	1995
Bank of China	Data	1996[2]
Ministry of Foreign Trade	Data/Voice	1996[2]
Yunnan Tobacco Corp.	Data	1996[2]
MPT Emergency VSAT Network	Voice	1996[2]
Ministry of Water Resources	Data/Voice/Video	1997[2]
Ministry of Public Security	Data/Voice	1997[2]
Nuclear Energy Emergency VSAT	Data/Voice	1997

Notes: [1] Initial operation phase, many networks have expanded in following years. [2] Estimated time of operation on Ku-band on AsiaSat-2.

Source: CTR Group, 1996.

Development of VSAT technology can be divided into three generations.
VSAT technology began in the early 1980s when the concept of VSAT was introduced. During the first generation (1980-85), access scheme (remotes to hub) was simple and rugged such as Aloha with high contention rate, hence low link efficiency. There was very limited functionality in network management and control, and the hardware was expensive. The second generation (1985-88) saw development in new access schemes such as slotted Aloha and TDMA, that increased link efficiency significantly. During this time, hardware was further refined and became modular to increase reliability and reduce costs. Many VSAT companies contributed to the development at this stage, but their designs were largely proprietary. The most significant development of VSAT technology took off during 1988-92, concurring with distributed computing environment, i.e., LAN server vs. mainframe. During this time, open communications standards were complied, such as OSI and X.25, and common communications protocols supported including SNA/SDLC, HDLC, TCP/IP, and computer networking protocols. Access scheme was further improved with flexibility between slotted Aloha, TDMA and allocation modes. Since then, VSAT technology is further advanced with more efficient transmission with higher throughput such as frame relay by eliminating error detection and acknowledgment frames. Network management systems have become very

sophisticated with features like dynamic slot planning, real-time protocol analyzer, software downloading, fault isolation and on-line troubleshooting.

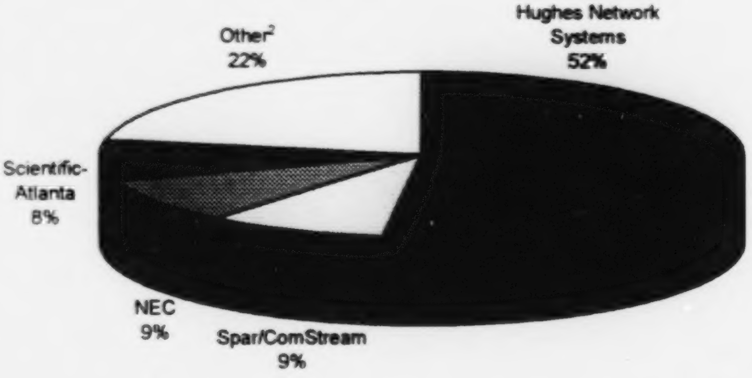
In addition, VSAT technology has been applied in data broadcast as a convenient means for information distribution. The largest networks are the Shanghai Stock Exchange with more than 2,500 receive-only sites and Shenzhen Stock Exchange with more than 300 sites. VSATs are also being used in paging service with roaming in anticipation that nationwide paging might thrive as the result of growth in telephones and voice traffic.

Competition in Equipment Supply

The huge market potential has attracted many foreign VSAT system/equipment providers to China. Foreign equipment suppliers have taken the advantage of timing in their entry since China relies almost entirely on imports due to sophisticated design and high costs in manufacturing.

Figure 2

Market Share by VSAT Suppliers[1]



Notes: [1] Based on the number of contracted networks, not size of network. Market share includes data broadcast networks but not Intelsat standard stations. [2] Including EF Data, Gilat(Israel), IDC(Canada), Linkcom(Taiwan), Mainstream, SkyData, STS, TIW, and Tridom.

Source: CTR Group, 1996.

Almost every foreign VSAT manufacturer with international presence has entered China's VSAT market and are vying fiercely in the following segments: voice, data, broadcast, and hybrid applications. CTR Group statistics show that Hughes Network Systems is by far the leading the market share in China's VSAT market, followed by NEC and Spar/ComStream (Figure 2).

Network Utilization

Although the intention of deregulating the VSAT service market is allow non-MPT operators to offer public access, few have attained a sizable customer base, let alone to be profitable. Many VSAT networks have difficulty in marketing their service and creating traffic volume. This is particularly the case in data broadcast networks for paging service. A network in Shanghai, for example, had only three customers signing up for paging service after investing $1.3 million, and its future remains uncertain.

Under utilization is even worse among private networks for internal voice and data communications. A CTR Group survey found that many private networks are designed under the guidance of acquiring highest transponder bandwidth and network capacity for a given budget, which has resulted in excessive capacity than actually needed. Moreover, many private VSAT networks have little consideration in return on investment since the budget is allocated from the central government and there is a lack of internal audit on ROI for most private networks. As a result, almost all private VSAT networks in China are operated at a loss for an unknown amount. Utilization of space segment is about a half or one third of acquired bandwidth. Channel utilization is even lower, typically no more than a few hours a day.

Another reason for low utilization is limited flow of information both in variety and content. Despite the hurry in VSAT deployment, communications means such as voice messaging and e-mail are still novel to most users, although the network is designed to handle complicated tasks Social acceptance of new communication behavior is expected to take a long time and will have a strong impact on the future development of VSATs in China.

Evolving Trends

CTR Group believes that China's VSAT market has entered a new phase in its development. During the take-off period between 1991-94, the market was concentrated in acquiring transponders and setting up physical networks. Beginning in 1995, the pace of network construction has slowed down with respect to number of contracts. Instead, the market has begun to pay attention to network operations, applications, and upgradability. In addition, the following conditions have contributed to the changes of China's VSAT market.

1) Rapid implementation of terrestrial networks for voice and data. Development of PSTN and data networks has been in parallel with satellite communications in China. More than 10 million new lines are added to PSTN each year, and the total number of telephones have exceeded 60 million by 1996.

Meanwhile, data networks have been deployed at an astounding pace: **ChinaPac**, which provides X.25 data service at 64Kbps, covers more than 700 cities and 2,000 counties; **ChinaDDN**, on the other hand, supports data throughput up to 2.048Mbps on fiber optic cable backbone network. Newly deployed **ChinaNet**, an access network to the Internet and a platform for local content and communication, after a short delay in early 1996 , is picking up pace in recruiting users across the country and developing services in the Chinese language. These data networks provide various public services including virtual private networks, frame relay, e-mail, database retrieval, bulletin board, EDI, and access to the Internet. According to official statistics, there are more than 100,000 users and growing 20 percent a month. Primary data customers include banks, securities, customs, trade organizations, research and educational institutions. Data services are expected to grow rapidly amid development of high-speed data networks like SDH and ATM, as well as new services.

2) Cost for terrestrial network is significantly lower than VSAT networks when the user has to pay for hub and uplink equipment

and space segment. Studies indicate that when a data network with fewer than 50 VSATs with regular traffic, cost per site will be significantly higher than terrestrial facilities for similar applications.

3) VSAT networks may experience more down times due to network/equipment reliability, transponder performance, as well as interference such as inter-modulation and from microwave path (especially C-band). In addition, VSATs operating on Ku-band are susceptible to rain face and wind load, resulting in unexpected carrier loss and network downtime.

4) Demand for voice VSATs continues to decline as the result of improvements in PSTN and service. Instead, VSAT will focus on specific requirements such as hybrid data/voice networks for remote areas not covered by terrestrial data networks, and/or applications where information collection is an essential function, such as banking, retailing, traffic control, disaster monitoring and prevention. In these applications, VSATs will continue to enjoy a strong niche over terrestrial networks.

5) Supply of Ku-band transponders. In recent years, China has experienced a series of disappointments in satellites launches with Ku-band payload. The first such failure, **APStar-2** was destroyed in early 1995 due to an explosion during launch. In August, launch of **ChinaSat-7** was failed due to a premature firing termination of rocket.

At present, **AsiaSat-2** is the only satellite in service providing both national coverage and Ku-band transponders. However, AsiaSat reported soon after launch that all 9 transponders on AsiaSat-2 have experienced power loss which may require re-design of VSAT networks and link calculations to maintain network availability and quality of service. Although there will be more Ku-band transponders in the future, risks in launching business and quality of payload will likely be a concern among many users who intend to use higher frequency bands for point-to-point communications at a lower costs for ground transmission equipment.

Technology Transfer

At present, China does not manufacture VSAT systems due to sophisticated design and limited resources. Imports are almost the only source for VSAT supply in China, and there has been little competition from domestic suppliers. CTR Group estimates that total annual contracted value of VSAT sales is between $20-25 million.

However, fierce competition among foreign suppliers has generated a downward trend, causing profit margins to diminish considerably, sometimes even at loss for suppliers. Many Chinese customers have learned to leverage their buying positions by using one supplier's bid to press another to a lower level. Another leverage tactic is to bundle a service center or spare part depot with the total price of network. Some service centers have turned out to be cost centers with limited repair capabilities and unskilled staff.

Faced with increasing difficulty in marketing and sales, many foreign suppliers have concluded that making sales alone in China can soon become a vanishing victory and may quickly be replaced by competitors engaged in technology transfer. Experiences of foreign VSAT vendors in China have shown that technology transfer is key to winning the market in the long run by localizing product design and manufacturing.

The change has encompassed the Chinese policy that communications technology and products must eventually be made domestically to avoid technological disadvantage and high costs. During the interim, China is willing to trade its market for technology before it can catch up. This national policy has applied to many technology intensive industries and appeared to be working, as in the case of automobile, energy, electronics, and infrastructure.

Joint venture has been taken as the most effective means for technology transfer. Foreign VSAT suppliers are encouraged to set up joint ventures with domestic partners, usually network operators, factories, import/export companies, and research centers. Most joint ventures begin with SKD or CKD, taking advantage of lower customs duties and low cost of labor and resources. Some joint ventures have become more sophisticated in engaging in design and manufacturing. Key components (i.e., ASICs) and crucial software (i.e., network management systems) still need to be imported under licensing agreements.

Some foreign VSAT companies take joint venture as integral to their long term strategy for China. Hughes Network Systems, for example, has formed a joint venture with four Shanghai partners to manufacture its TES and NOC products. It is almost impossible to maintain a large base of VSATs in China without a local manufacturing and repair facility.

For others, large scale technology transfer poses as a dilemma. For companies that already enjoy a large market share in China, joint ventures will certainly enhance their competitive position with lower price and improve response time. For companies with limited market, joint venture can be a costly and risky proposition. Experience in China shows that many Chinese want to lure foreign companies into a joint venture deal when the real intention is to promote their own market under a foreign name and reputation and little attention is made to customer needs.

Intense competition and emphasis of technology transfer will have far reaching impact on China's VSAT market. First, foreign companies with limited technological capacity and financial resources will likely be pushed out. The market will become more concentrated in key technologies and products suited for applications, typically SCPC/DAMA for voice, TDM/TDMA for interactive data, and MCPC for video distribution, etc. The trend began in 1995 when small companies with alternative designs found very difficult to sell their products despite of seemingly superior features and more cost-effective for the Chinese requirements. Second, Chinese will begin to take shares of VSAT sales. Before, VSAT market was almost entirely closed to Chinese companies. With joint venture, they are now able to share profits with foreign partners by making and selling foreign products. It is expected that shares by Chinese companies will increase as they become more competent in VSAT design and manufacturing. Finally, images of foreign VSAT suppliers will change as more components will be supplied by domestic sources. Although foreign companies can still license key technology, virtual market share by Chinese will increase significantly if technology transfer by joint venture succeeds and the present market conditions remain unchanged.

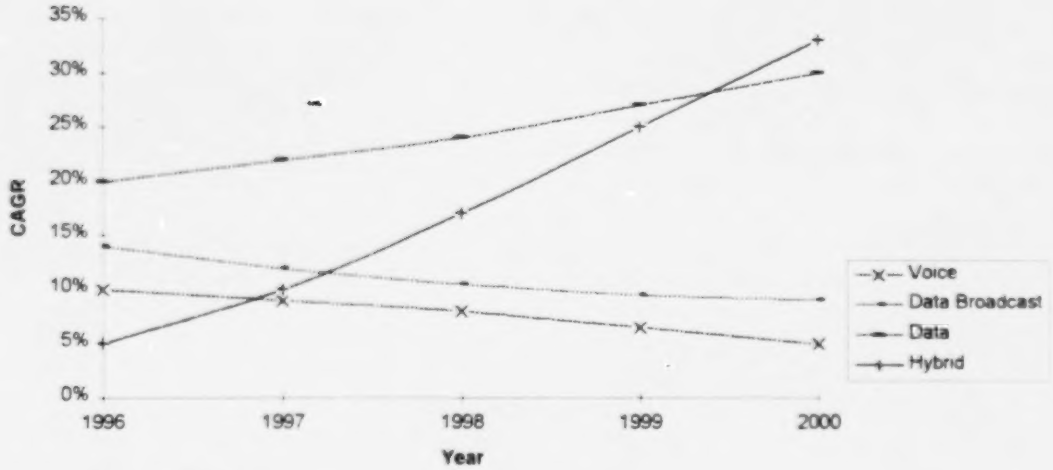
Growth Prospects

After 4-5 years of strong growth, China's VSAT market has entered a mature phase, during which the market has experienced level-off annual growth rate in contracted networks, more tailored design for data and hybrid applications, and the market is moving more toward industry specific applications.

It should be noted that despite the fact that contracted networks have decreased, the size of systems tend to become larger. Yunnan Tobacco VSAT network, for example, is said to eventually reach 2,000 sites for retail chain operations if the project is carried out as planned. Another case is the new VSAT network for the Ministry of Water Resources, which can grow to thousands of VSATs for every reservoir and major river in the country for flood monitoring and prevention. In both cases, VSAT networks serve as the best suited solutions for specific applications where terrestrial networks are difficult or costly to cover. CTR Group believes that although the number of viable VSAT customers are not infinite, special applications and emerging demand do contribute to a sustained basis for future growth. Figure 3 is a growth projection for various VSAT market segments between 1996 and 2000.

Figure 3

VSAT Growth by Market Segments



Source: CTR Group, 1996.

Changing market dynamics will play an important role in the growth prospects of China's VSAT market. First, as the country is actively engaged in information superhighway initiative (represented by the "Golden Projects" such as "Golden Bridge", "Golden Card" and ChinaNet), VSATs will likely create a niche market in providing cost-effective solutions for new information service providers taking advantage of value-added service in a deregulated environment. In addition, it is anticipated that satellite-feed cable TV/video distribution and video-on-demand service will soon become the next growth areas as information and entertainment services will accelerate in household market. Second, competition in the service market will promote VSATs as a viable contender for national and local networking solutions. **China Unicom** (China United Telecommunications Corp.), the second national carrier, was created in 1994 to introduce competition with the MPT in basic and value-added services. It has deployed satellite standard stations for routing trunk traffic and VSATs for routing data traffic. Third, while a large number of VSAT networks have been deployed at the national level, new opportunities will emerge at regional and provincial markets, many of them have rugged terrain and dispersed population, and it is uneconomical to use terrestrial networks. Shanghai VSAT Co. and Shenzhen VSAT Co. in Guangdong province, for instance, are actively marketing local networking solutions for data customers. Fourth, many current VSAT users will expand service and upgrade their networks, which creates new demands for new VSAT technologies and sales. Lastly, emerging personal services like mobile satellite services (MSS) and PCS are expected to open new markets for VSATs for access and interconnection.

CTR Group predicts that the future of VSAT market in China will continue to diversify and grow. In addition to continuing developments in terrestrial networks which will likely affect VSAT market in many ways, the market will evolve both driven by new applications and services while being pushed by new technologies and features that can improve link efficiency and network performance, given that the current regulatory environment remains the same. These forces will shake out disadvantaged players, from more than a dozen at present to about 5-6 that have advanced and market proven products, financial resources, service capability, and more importantly, long term commitment to the development of China's VSAT market.

Worldwide Probe of the Telecommunications Development Gap From Developing Country and Developed Country Perspectives

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(See Sunday Opening Session Section in these *Proceedings*)

Regulatory Solutions for Global Systems

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1. Abstract

In the past several years, a number of global telecommunications systems which have been termed by the International Telecommunication Union as Global Mobile Personal Communications by Satellite (GMPCS) have been proposed that will have similar operational elements: providing worldwide, wireless, portable communications anywhere, at anytime. GMPCS systems will provide tremendous benefits, especially to the developing world, when their implementation begins in 1998. At the same time, GMPCS has presented unprecedented regulatory issues that are being addressed on the national, regional and global level.

2. Introduction

2.1. Description of GMPCS Services

This paper will focus on the big low-earth orbit satellite (Big LEOs) systems, such as Iridium, Globalstar, I-CO and Odyssey, that provide voice telephony, fax, and data via constellations of up to sixty-six satellites. Big LEO GMPCS will serve the business traveler with global communications anywhere on Earth, provide services to remote areas that are currently unserved, under served or unable to be served, and will become an essential element in the provision of emergency and disaster relief communications.

At the same time, most GMPCS operators will ensure that the dual mode handsets will not bypass local wireline or wireless systems, and that these handsets can be turned off where a country has not agreed to license the system. Services will be provided through nationally approved service providers and will be connected to the existing PSTN infrastructure. All of these local parties will be fairly compensated while not having to extend their existing infrastructure.

GMPCS operators, with the support of government regulators, have expressed that their goal is to involve local companies in every country in the world -- as service providers, distributors, as well as service oriented businesses such as advertising and marketing firms, shipping, technical support specialists -- so that people in every country will be not only receiving the benefits of GMPCS but will also be working with us to serve the local market, and in turn sharing in the financial benefits.

2.2. Introduction to the Regulatory Issues Presented by GMPCS

As you can imagine, GMPCS is presenting challenges that present a unique opportunity for global regulatory solutions. There is a movement towards concerted licensing policies through organizations such as the International Telecommunication Union (ITU), the Asia-Pacific Telecommunity (APT), and the European Community (EC). It is truly essential that these efforts succeed in order to ensure their viability and ability to achieve GMPCS's common objectives of providing wireless communications to every corner of the globe.

The ITU's First World Telecommunication Policy Forum, held in October 1996, provided a framework for developing a global consensus for equitable and flexible licensing policies that all nations could adopt with sufficient comfort while not abandoning their national sovereignty.

The ITU has already played a major role in the development of GMPCS. First, through the policies advocated by its Secretary General, it quickly recognized that private industry could play a major role in the development of telecommunications services, a concept which is now widely accepted. Second, through the allocation of frequencies on a worldwide basis, the ITU provided potential GMPCS operators with the necessary spectrum resources to proceed with their system construction plans.

In order to provide worldwide service, GMPCS will have to obtain individual regulatory authorizations from every country in the world. This is a daunting and difficult endeavor. To achieve this objective, a number of policy and regulatory issues must be addressed by every nation. In the vast majority of cases, no regulatory framework exists and no technical or regulatory resources are available at a national level. The Policy Forum suggested a framework for national, regional and worldwide application.

From a regulatory perspective, the major challenge is to ensure that first there will be universal licensing of the telecommunications equipment used in the provision of telecommunications services, and second that this equipment will be allowed to freely cross national borders. The global nature of these systems makes roaming an essential and fundamental feature of the overall licensing process.

Almost half the world has accepted the GSM standard, the unencumbered transborder movement and use of GSM terminals, and the principles that apply to GSM roaming -- one protocol used worldwide enables free circulation -- can also be applicable to GMPCS.

To facilitate free roaming of handsets across borders, uniform technical and type approval standards must be accepted globally and on a national level. One system equals one standard that ensures uniformity worldwide.

3. Policy Considerations and Development

Policies for the facilitation of GMPCS systems must be done on a natioanl level. The results of the Policy Forum gave guidance to national regulators on how they may wish to implement GMPCS.

The delegates to the Policy Forum prepared five Opinions(1) that national regulators may wish to consider to facilitiate the entry of GMPCS systems in their countries. The delegates recognized the benefits of GMPCS systems and their Opinions were geared towards introducing GMPCS in a timely, orderly fashion. In Opinion 2, Principle 4, GMPCS Regulation, the delegates stated that:

> *National regulators should, in a timely manner, consider the benefits of creating a simplified, non-discriminatory and transparent regulatory environment, particularly with respect to such matters as service licensing, gateway station authorization, interconnection arrangements and user terminals, in which GMPCS services are regulated only to the extent necessary ...*

Opinion 2 reflected the general international trend towards regulation of GMPCS systems. It was very important, though, that the ITU, as a highly respected international body, endorse these key concepts in order to give them further validity in the internatioanl community.

Global systems will need to have regulatory approvals in all countries; accordingly, the national regulatory environment must be clearly set forth to enable system operators and their local partners to obtain all necessary approvals. Predictable and transparent regulations are a key factor in defining market access opportunities.

A key consideration before licensing is the policy that a country will adopt. Providing for equitable, open market access is encouraged, of course. Competition amongst systems will result in the best services and prices for consumers. In addition, a fair "level playing field" will allow market forces to determine market success.

Approaches to national policy development have either been to create a new policy or to classify GMPCS into the same category as an existing technology. Either choice has ramifications.

3.1. National Policy Development Trends

Developing new policies for GMPCS systems, or any new technology, can take quite a bit of time. For instance, in the United States, the Federal Communications Commission took approximately five years to prepare its Big LEO Report and Order(2). The FCC created a policy for Big LEOs based on a public rule-making procedure that allowed the applicants and interested parties to comment on and influence the rule-making process. Of course, the FCC's approach also provided for the maximum amount of fairness for all applicants.

While developing a new policy can take time, national regulators from around the world have recognized that new technologies are constantly being introduced and that it is difficult to develop new policies as quickly as the technology is being created. This concern needs to be compared to the thought that the process of developing new policies entails studying the new technology and the applicant's system feasibility, thus allowing regulators to determine if the proposed system will actually be implemented, preventing issuance of licenses to possible "paper systems." Another key consideration is that when regulators take the time to develop new policies, they have increased freedom to introduce innovative measures, such as having system construction milestones that must be met before licensure.

Sometimes, regulators decide to save time and administrative burdens by making new technology such as GMPCS "fit" into an existing policy. With GMPCS, many regulators felt comfortable with this approach. Because of its varied applications, GMPCS has been licensed under the existing national criteria developed for mobile/cellular services, satellite, and international value added network services (IVANS). Often Administrations have national joint venture and foreign ownership laws that require global system operators to work with national operators, further ensuring that national interests will be protected.

There are, naturally, ramifications for using existing regulatory policies. Existing policies can be used as quickly as the new technology is created, thus ensuring timely market entry. When existing policies are used, though, it is important that the policy allows for new entrants, competitive safeguards and general fairness principles, while still accounting for the issue of utmost concern to governments, their national sovereignty. By using an existing policy, regulators instill confidence to applicants and regulators because both parties will be working with familiar rules, thus potentially allowing for quicker licensing and introduction of new technologies in the marketplace.

4. Initiatives towards Achieving Free Circulation of GMPCS Terminals

The delegates to the Policy Forum identified worldwide transborder movement and use of GMPCS terminal equipment as a key element to seamless global communications. Opinion 4 on the Establishment of a Memorandum of Understanding to Facilitate the Free Circulation of GMPCS User Terminals, was established because the delegates:

> *due to their global...coverage, the possibility of being able to operate GMPCS terminals without geographical constraint raises regulatory concerns iwth regard to "free circulation"*

The delegates to the Policy Forum also developed a draft Memorandum (the "GMPCS MoU") to be signed by interested parties. Signatories to the MoU would endorse free circulation of GMPCS terminals with regard to type approval, licensing and marking of terminals, customs arrangements and access to traffic data.

The ITU has "fast tracked" the MoU, and has an aggressive schedule to complete the document by July 1997. This schedule could be met due to prior precedents that are a useful guide.

4.1. Precedents to the GMPCS MoU

Before the Policy Forum, regional bodies had clearly recognized that free circulation of GMPCS terminals is a key element to the system's usefulness to users and towards meeting the GMPCS goal of global communications:

> *"Facilitating the free circulation and use of hand-held equipment throughout the world is expected to be one of the more important challenges. Current regulatory mechanisms are not sufficiently developed to accommodate this easily."(3)*

The first precedent for regional free circulation for mobiles can be found in Europe. The second precedent for mobiles, Global System for Mobile-communications (GSM), spans well beyond Europe. GSM users have unencumbered transborder movement and use from the Baltic to the Pacific -- throughout over 90 countries. The European Union (EU) has indicated that its current Mutual Recognition Directives for telecommunications terminal and satellite earth station equipment (91/263/EEC and 93/97/EEC)(4) should apply to handheld GMPCS terminals. Currently in Europe, under these Directives, mobile handsets freely circulate with their users. Mobile operators with technologically compatible equipment in Europe have commercial roaming agreements with each other for ease of use by their customers. In addition, the European Technical Standards Institute (ETSI) has recommended that the European Commission apply the "principle of freedom of circulation for satellite PCS handsets without additional licensing procedures."(5) The EU Directives and the principles contained therein could also be implemented by the CEPT countries to extend the free circulation of GMPCS handheld terminals to one-quarter of the world. Most of the GMPCS systems that have been proposed plan on utilizing dual-mode handsets that can provide both satellite and cellular communications; so that from a regulatory perspective, half of the handset is currently able to freely circulate.

4.2.1. The GSM Example

Operators from nearly half the world have agreed to allow transborder movement and use through the GSM Memorandum of Understanding (GSM-MoU), which allows for seamless mobile communications throughout the world. The GSM project is an excellent example of successful coordination of a mobile system and standard system protocol.

Today, 168 members in 92 countries have committed to promoting the GSM platform as the world's mobile standard. The GSM-MoU Association has created a worldwide structure for free circulation of terminals. The GSM protocol is based on a common technical standard, and this allows type-approved GSM mobile stations to be used without restriction in signatory countries. There is coordinated type-approval of mobile stations with a single specification, conformance test and mutual recognition of GSM terminal equipment. Users may roam onto other operator's networks with bilateral roaming agreements that are facilitated by the Association's standard roaming agreement. GSM-MoU signatories easily utilize each other's GSM-family networks for seamless mobile communications for the benefit of their subscribers. The GSM MoU Association also has regional interest groups that work towards resolving and harmonizing issues that face the Association's members.

4.3. Regulatory Action Needed to Facilitate Free Circulation of GMPCS Terminals

Obviously, GSM has led the way in initiatives that have provided for free circulation of terminal equipment. Currently, GSM is in use, or is planned to be used, throughout Asia and the Pacific. All of these nations have adopted the policy of allowing transborder movement and use of a mobile system. The next step will be to expand the focus from GSM to other technologies, whether they be new ones such as GMPCS or old favorites such as AMPS. The need for action is further evidenced by the growing initiatives towards making mobile equipment interoperable -- for instance, GSM/AMPS interoperability is now a reality, and the future is moving towards technology that can utilize all of the world's mobile protocols in one "smart" handset.

Through the ITU, regulators and operators will work together to ensure that borders do not hinder the goal of seamless global communications. This effort is already happening for one type of technology, and these efforts have shown us that it can be done.

First and foremost, nations should adopt policies that allow for unencumbered transborder movement and use for technologically similar equipment(6) once a nation has licensed GMPCS in their country and to have approved the GMPCS handsets. National policies should also be flexible enough to be adopted for new technologies and future interoperability between existing technologies.

The ITU has already encouraged nations to adopt free circulation policies and to sign the GMPCS MoU. Besides encouraging nations to adopt policies of transborder movement, regional and international bodies will continue to play a key role in forming consensus on issues that will arise, such as creation and agreement on a common label or marking for the equipment that will be allowed to circulate freely, encouraging acceptance of recommended global equipment standards or technical specifications, expedited customs clearance, and to deal with any other transborder certification requirements. An essential element of GMPCS is that the terminals must have essentially the same technical standard and that "global approval regimes for handsets [be] based only on essential requirements."(7) Truly seamless use and efficiency require that there be a uniform worldwide protocol and marking for equipment in order for the equipment to work anywhere effectively.

Finally, all parties -- national regulators, regional alliances, and international bodies -- should realize that a zone of seamless transborder equipment movement will stimulate their economies and aid in national and international humanitarian efforts, such as disaster relief. Network operators from the largest to the smallest nations could form international bi- and multi-lateral network roaming agreements with each other for the benefit of their users. Users will have true worldwide service, which will lead to increased commerce, trade, and development.

5. Conclusion

The international community recognized that the major issues presented with GMPCS had to be resolved through special initiatives tailored to the system's unique attributes. The great success of the Policy Forum in clarifying these issues, and to providing suggested courses of action in order to facilitate implementation of these systems, will be of great assistance to both operators and regulators.

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(4). On December 6, 1995, the European Commission proposed a new Directive (COM(95)612) that would replace both 91/263/EEC and 93/97/EEC. The new Directive has the goal of consolidating both Directives to ensure that the Community rules remain clear and readily understandable. The content of the Directives will not change.

(5). European Satellite PCS Proposal at 26. ETSI also noted that "every effort should be made to extend this principle to the whole world and not only Europe." Id.

(6). GSM succeeded so tremendously because it was based on one technical specification, one protocol. Global systems that have one standard will be the key systems that can and will be able to freely circulate worldwide.

(7). European Satellite PCS Proposal at 26. ETSI noted that "essential requirements" are "user health and safety, effective use of spectrum, legal interception, and, if required, interworking with the public networks." Id.

Restructuring of the Telecommunications Sector in Southeast Asia: Policies and Pitfalls

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1. Abstract

The countries of Southeast Asia range from the economically dynamic city states of Singapore and Hong Kong[1] to the diversifying economies of major ASEAN members to low income countries struggling to build their economies and infrastructure. This paper examines experience to date from various approaches to restructuring the telecommunications sector and modernizing the infrastructure in Southeast Asia. Examples are drawn from Singapore, Hong Kong, Malaysia, the Philippines and Vietnam.[2] Analysis focuses on issues of the government role in licensing, oversight and consumer protection; conflicts between government interests in regulation and operation, and government attempts to control access to content of the newly introduced technologies of satellite broadcasting and the Internet. Lessons and strategies relevant to privatization and restructuring in other Asia-Pacific countries are highlighted.

2. Basic Indicators

The countries chosen for this analysis share some economic and demographic similarities, but differ in many respects, including the structure of their telecommunications sector. (See Table 1).

Singapore and Hong Kong are the most developed, falling within the World Bank's high income classification, which also includes Japan and the other OECD nations of North America, Europe and Oceania. Singapore's trading economy is highly information intensive; its goal is to become an "intelligent island" that can serve as a regional commercial hub and lure international companies from Hong Kong. Official policy in Hong Kong is much more "laissez faire," but it could already be considered an "intelligent island" based on its high utilization of telecommunications and information-intensive economy.

Malaysia is one of the fastest growing economies in the region, with much of its income derived from petroleum. It also has attracted high technology industries that have set up assembly plants in the Penang free trade zone, and is intent on further diversifying its economy. The Philippines status as a low income country reflects the stagnation of the Marcos era, high population growth rates, and the continuing domination of the economy by a few powerful families, despite reforms by the Ramos government. Vietnam has become the investors' darling apparently because of its economic potential and entrepreneurial spirit, but it remains among the world's poorest nations after decades of war, exacerbated by a centrally controlled economy and elderly Soviet-trained leadership.

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[1] Hong Kong, of course, is not a country but a British territory, and will revert to Chinese control as a Special Autonomous Region on July 1, 1997. However, as it has a distinct economy and telecommunications policy, it will be considered as a separate entity in this paper.

[2] Much of the analysis in this paper draws on research conducted by the author in these countries supported by a Fulbright Asia-Pacific Lectureship in the spring of 1996.

Table 1: Basic Indicators of Selected Southeast Asian Countries

	World Bank Classification	Population 1993 (millions)	GDP/Capita 1993 (US$)	Teledensity 1994 (lines/100)
Singapore	high income	2.8	19,214	54.0
Hong Kong	high income	5.8	18,687	47.3
Malaysia	upper middle	19.5	3,392	14.7
Philippines	lower middle	66.2	817	1.7
Vietnam	low income	72.9	181	0.6

Source: ITU, *World Telecommunication Development Report*, 1995.

3. Structure of the Telecommunications Sector

Each of the above countries has taken a different approach to organizing its telecommunications sector (See Table 2). Singapore, Malaysia, and Vietnam are evolving from a PTT structure carried over from their colonial administration, in which telecommunications was a government-operated monopoly, under the same jurisdiction as the postal service. Hong Kong's telecommunications were provided by Cable and Wireless, the formerly government-owned company that provided telecommunications services for Britain's colonies. The Philippines inherited a primarily Vietnam has retained its PTT heritage, with telecommunications policy and operations still under government control. Telecommunications policies are set by the Directorate General of Posts and Telecommunications (DGPT) which was separated from the Ministry of Communications and Transport in 1992. A new entity, Vietnam National Posts and Telecommunications (VNPT), American model, with a large dominant private company (PLDT, the Philippines Long Distance Company) and some services in rural areas provided by national and municipal governments. was established to operate the national network under the regulation of the DGPT. The VNPT established several subsidiaries including Vietnam Mobile Services (VMS), Vietnam Data Corporation (VDC), Vietnam Telecoms National (VTN), Vietnam Telecoms International (VTI) and the Vietnam Postal Service (VPS). VNPT is also responsible for transmission of radio and television.

Recognizing the need to develop its national infrastructure, the government issued an information technology master plan called ITP-2000 in 1993. There is a potential for separate government sponsored IT networks to become alternatives to the VNPT networks. However, the DGPT has retained control to date, despite pressures from some research institutes and government departments to obtain Internet access, which was not available from the VNPT. In 1990, Malaysia partially privatized its former government operator, Telekom Malaysia, which was corporatized in 1984. Jabatan Telekom Malaysia, under the Ministry of Energy, Telecommunications and Posts was converted to

Table 2: Structure of the Telecommunications Sector in Selected Southeast Asian Countries

Country	Local	Trunk	Int'l	Mobile	VAS
Singapore	M-PP	M-PP	M-PP	M-PP	C
Hong Kong	C	C	M-PP	C	C
Malaysia	M-PP	C	C	C	C
Philippines	M-P	C	C	C	C
Vietnam	M-G	M-G	M-G	M-G	M-G

M = monopoly C = competitive

G = government owned P = private PP = partially privatized

a regulator. Telekom retains a local monopoly and has responsibility for rural services. However, competition has been introduced in cellular services, pay phones, long distance and international services. The new entrants are all local companies, many with strong ties to Prime Minister Datuk Seri Mahathir Mohamad, or other members of the ruling party UNMO (United Malays National Organization).

Although Singapore Telecom has been partially privatized, the government has been reluctant to allow competition. In 1992, Singapore Telecom was corporatized, taking over the former commercial functions of Telecommunications Authority of Singapore (TAS), which is now the regulator. The company was given a fifteen year monopoly by TAS in domestic and international telephone services and leased circuits. It was also given exclusive rights to provide cellular mobile service for five years, until 1997. Singapore Telecom is now the largest company listed on the Stock Exchange of Singapore. The government of Singapore will continue to hold, at least initially, approximately 80 percent of the privatized company, and will likely hold a "golden share" indefinitely.

In 1993, more than 3,000 international companies hubbed their telecommunications through Singapore, but fewer were regionally based in Singapore than in Hong Kong.[1] However, Singapore has been aggressively marketing itself as an alternative to Hong Kong because of the uncertainty of the post-1997 political environment in Hong Kong. Singapore has attracted several regional satellite uplink operators including HBO, ESPN, and ABN (Asian Business News), among others. Ironically, these operators can transmit from Singapore, but their programs cannot be received by Singaporeans, who are not permitted to own satellite antennas.

In Hong Kong, the dominant carrier is still Cable and Wireless, through its subsidiary, Hong Kong Telecom (HKT), in which it retains majority ownership.(The other major investor is the Chinese International Trust and Investment Company (CITIC), an arm of the Chinese government.) Regulation is the responsibility of the Office of the Telecommunications Authority (OFTA), which is generally modeled on the U.K.'s OFTEL and Australia's AUSTEL. (In fact, the

Director General was recruited from AUSTEL.) Following the Hong Kong government's policy of "positive non-intervention", OFTA has liberalized the sector into one of the most competitive in the world. The extent of its future autonomy in telecommunications will depend on China's interpretation of the "one country, two systems" policy that will come into force with Hong Kong's reversion to China in July 1997.

HKT remains the sole provider of all international service, having been granted a 25 year monopoly in 1981 (before OFTA) that will not expire until the year 2006. HKT's local monopoly expired in 1995, after which OFTA introduced local competition. Three operators have been licensed to compete with HKT in the provision of fixed-network service. By linking with callback operators, they have effectively introduced international competition, despite HKT's international monopoly.

Hong Kong has the one of the highest concentrations of wireless communications in the world. By 1994, there were 431,800 mobile subscribers, or 7.4 per 100[2] using services provided by four cellular operators on seven networks covering five analog and digital technologies. Hong Kong also has the world's highest concentration of pagers, with almost one pager for every four inhabitants. In addition to the four cellular operators, there are also four telepoint cordless telephone (CT2) licensees (service started in 1992), and 36 paging service operators.[3] Up to six operators are being licensed to provide Personal Communications Services (PCS), with very small handheld handsets accessing microcells.

The Philippines is perhaps the most open of ASEAN markets, with more than two dozen companies offering telecommunications services, but most are controlled by a small circle of ruling families. They form alliances with foreign companies for financial backing and technical expertise, but the alliances are volatile, with considerable turnover. The Philippine Long Distance Telephone Company (PLDT) is the dominant operator with 86 percent share of the market: the remaining 14 percent is the responsibility of some 50 other franchises. PLDT has been a fully private operator since 1928; its franchise extends until 2028.

Several private carriers have entered the market to provide local, long distance, and value-added services. In 1995, seven record carriers provided domestic telex, facsimile, and leased-line services; four provided international services. There are also several private carriers for paging and data communications. Five companies have been granted provisional authority to establish national cellular networks.

4. Regulatory Issues

4.1. Conflicting Mandates

Countries that are in transition from a PTT structure to a commercialized telecommunications sector typically face difficulties in establishing an autonomous regulator. Typically, the regulatory staff is drawn from part of the operator that was responsible for tariffs, standards, and intergovernmental affairs. Neither the Telecommunications Authority of Singapore (TAS) nor Jabatan Telekom in Malaysia is truly independent of Singapore Telecom or Telekom Malaysia, where many of their former colleagues now work. TAS still interweaves regulation, operation, and policymaking. Its function is not only to regulate but also to develop and promote the telecommunications industry in support of the National Information Technology 2000 (IT 2000) Plan to make Singapore an "intelligent island."

TAS also receives about 60 percent of Singapore Telecom's surplus, and may receive revenue from licenses and administrative fees and may raise capital through stocks and bonds.[4] It would appear that TAS faces numerous potential conflicts of interest. However, Hukill concludes:

> "The close link between government, regulator and operator in Singapore must be seen not in terms of conflict of interest

> as might be the case in other countries, but as a tripartite strategy for development opportunity ....[5]

As long as what is good for ST is good for the country, this may be true. But as more competition is introduced, and users develop a stronger voice, TAS may find it difficult to play several policy roles.

Although Malaysia has separated its regulatory agency, JTM, from its now partially privatized operator, JTM is really not independent of either the government or STM. As in Singapore, its employees were formerly employees of the government-run operator. JTM only recommends decisions; it can be overruled by the Minister or by the Cabinet. Also, the government still sees Telekom as an important element of its industrial policy, and with its majority share, wants Telekom to be commercially successful.

The licensing process is opaque, with no obvious criteria and evidence of political cronyism in selection of successful licensees. The terms may also not be fixed; in 1996, the government decided that too many licenses had been awarded during the previous administration and election period, and indicated that it would like some licensees to buy out others, despite the fact that all had made investment plans and were building networks based on their license terms.

4.2. Tariff Reform

The price of international calling has dropped in many Asian countries, under pressure from authorized competition and callback services. The Philippines and Malaysia have authorized competitive international gateways. Singapore has retained its monopoly, but ST's tariffs are set to be competitive with a basket of tariffs from other countries. Callback services are also effectively lowering international rates for many customers. To access callback services, a customer dials a number, typically in the U.S., and hangs up before the call is answered. The callback operator's switch seizes the number data and dials the party back, setting up a circuit that originates from the cheap calling country. Callback is viewed with great consternation by administrations which have typically priced their international calls to generate revenue to extend and upgrade their domestic networks, or to keep local rates low.

Vietnam has one of the world's highest accounting rates, and perceives callback as illegal and apparently a significant threat to VNPT's revenues.[6] In contrast, OFTA in Hong Kong has effectively introduced international competition, in spite of HKT's monopoly until 2006, by licensing competitive local companies which are offering callback access. In fact, the Hong Kong government encourages its departments to use callback to save money.

Operators that retain a local monopoly may turn to their captive customers to make up for revenue lost through competition in domestic long distance (trunk) and international services. For example, in March 1996, Telekom Malaysia received approval from Jabatan Telekom to increase local rates significantly. There was no previous notification that such a change was under consideration, nor any mechanism for users to express their views.[7] One group of users who were likely to be significantly affected were Internet users. In fact, there was a protest from the government-owned Internet access provider, and a compromise was reached to introduce a new pricing structure for Internet access.

4.3 Setting the Rules for Competition

As competition is introduced, regulators must resolve issues such as network quality, network standards and compatibility, revenue sharing and interconnection agreements.

In the Philippines, Executive Order 59 issued by President Ramos in 1993 required compulsory interconnection of authorized public telecommunications carriers to create a nationalized integrated network and encourage greater private sector investment. This decision paved the way for other authorized carriers including small "mom-and-pop" operators to interconnect with the national backbone of large carriers. The Philippines was also divided into ten Local Exchange Carrier (LEC) service areas.

The NTC has left PLDT and the local exchange carriers to negotiate among themselves, intervening only if invited or if the parties cannot agree within 90 days. Since PLDT's network includes 90 percent of all installed lines, the other carriers have felt pressure to agree to PLDT's terms. PLDT had not designed its network for interconnection with numerous other carriers and had not budgeted for the transition. Also, PLDT acts as a bottleneck in high demand areas where the new carriers depend on the PLDT network. In mid-1996, the new carriers cited backorders for hundreds of trunks in Manila from PLDT.[8] Other issues to be resolved included billing protocols and cost allocations among the carriers.

Regulating the multiplicity of new operators is a formidable challenge, especially given the continued dominance of PLDT. Enforcing interconnection agreements and determining how to allocate costs among the carriers are among the daunting issues facing the NTC. However, policies it develops could become models for other countries in the region.

In Malaysia, Jabatan Telekom faces similar issues as it authorizes more competition. The new carriers cite problems with interconnection, numbering plans, procedures for obtaining construction permits and rights of way, and a prohibition on resale. Without the option of obtaining capacity from Telekom Malaysia at wholesale prices, new carriers are choosing to build their own backbone networks, which are highly capital intensive. However, the government is urging Malaysian industry to reduce imports in order to cut its foreign exchange deficits. Resale could help to reduce this deficit by creating an incentive to use surplus fiber and satellite capacity.

5. Extending the Public Network

5.1. Malaysia: The Carrier of Last Resort

Southeast Asian nations are using a variety of strategies to extend public networks to unserved communities, particularly in rural and remote areas. Malaysia has adopted the "carrier of last resort" approach, also found in Australia and the United Kingdom. Telekom Malaysia (STM) is required to provide service in less profitable rural areas, while competing with carriers which apparently can cream skim the most lucrative business and urban customers. Yet reserving a rural monopoly for Telekom Malaysia provides no incentive for the company to reduce costs for rural services.

A test may come with the availability of the MEASAT satellite, which would be very suitable for providing services in isolated areas of Sarawak and Sabah. It is unclear whether Binariang, which owns MEASAT, can obtain authorization to serve these communities directly, or whether STM would be required to provide the service. STM could lease capacity from MEASAT, but appears to favor building its own more expensive terrestrial networks. If STM does build its own more expensive terrestrial network, it will be following in the path of Telecom in Australia (now Telstra), which rejected in the 1980s the opportunity to use Aussat to serve remote settlements in the Outback, instead building its own microwave network, a more costly and less flexible system.

5.2 The Philippines: Incentives for Investment

The Philippines has adopted an innovative strategy to create incentives to install telecommunications networks in unserved areas. Licenses for international gateways and domestic services now require that operators also undertake to install several hundred thousand lines in an unserved region. Executive Order 109 issued by President Ramos in 1993 requires a total of five million landlines from gateway and cellular telephone operators. Each Cellular Mobile

Telephone Service (CMTS) operator is required to install a minimum of 400,000 local exchange lines. Similarly each International Gateway Facility (IGF) operator is required to install a minimum of 300 local exchange lines per international switch termination and a minimum of 300,000 local exchange lines, within three years from the date of authority to operate and maintain local exchange carrier service.[9]

The Philippines' policy of requiring licensees of international gateways and cellular systems to build networks in unserved parts of the country is a very innovative strategy to create incentives to invest in unserved areas. Although some observers have questioned the wisdom of this approach in that it may perpetuate internal cross subsidies, it shows promise as a model that may be emulated in other countries with large unserved territories. Some operators apparently see the new policy as a burden, while others welcome the opportunity, and anticipate profitable operations in their new franchise areas. Perhaps in a few years it will be possible to make a market in these rural franchise areas, so that rights to build and operate may be traded, with operators interested in expanding their franchise areas buying the obligations from those who find them a burden.

5.3. Vietnam: The BCC

Vietnam's new Foreign Investment Law, part of the constitutional reform of 1992 which adopted the guiding principle of "doi moi" or economic innovation, permits joint ventures and 100 percent ownership of assets. However, telecommunications is still regarded as important to national security; to retain government control, the DGPT has authorized only one form of foreign participation, the Business Cooperation Contract (BCC), which is an agreement between a foreign and Vietnamese partner for "the mutual allocation of responsibilities and sharing of product, production or losses, without creating a joint venture enterprise or any other legal entity."[10]

Vietnam's first BCC in telecommunications was with Telstra of Australia (formerly OTC) in 1988 to install INTELSAT earth stations in Hanoi, Ho Chi Minh City, and Danang for international communications. International revenues are shared between Telstra and the DGPT, which uses part of these revenues to expand the domestic network. Telstra also financed the DGPT's share of an optical fiber submarine cable linking Vietnam to Thailand and Hong Kong.[11]Operating companies from Singapore, Malaysia, Thailand and Hong Kong are also participating in ventures in services such as cellular, paging and payphones.

6. Misplaced Priorities? Access to Television vs. Telephones

There are striking differences in access to television vs. telephones in the region (see Table 3). In both Hong Kong and Singapore, there are apparently more telephone lines than TV sets. A probable explanation is that the economies of both of these city states are highly information-intensive, so that there is a higher proportion of business lines than would be found in other developed economies with greater land area. Also, the data on TV sets may underrepresent the actual number of sets per household. We can conclude that access to television and to telephone service is close to universal in both Singapore and Hong Kong.

However, television is more accessible in the other countries. Malaysia has 1.6 times as many television sets as telephone lines; it is likely that the disparity is more significant in rural areas. The Philippines has more than 7 times as many television sets as telephone lines, while Vietnam has more than 18 times as many TV sets as telephone lines. There may be a partial historical explanation in the Philippines and Vietnam. The Marcos regime heavily controlled the privately owned mass media to portray a favorable image of the country and its government, and siphoned off PLDT funds that could have been invested in extending telephone networks. The Vietnamese government operated both broadcasting and telephone service, giving priority to the mass

Table 3: Access to Television vs. Telephone Service

Country	Teledensity	TV Density	Ratio TV Sets/Tel Lines
Singapore	47.3	38.0	0.8
Hong Kong	54.0	35.9	0.7
Malaysia	14.7	23.1	1.6
Philippines	1.7	12.1	7.1
Vietnam	0.6	11.0	18.3

Derived from: ITU, *World Telecommunication Development Report*, 1995

media as a means of disseminating government-approved information. The relative inaccessibility of telephone service may also reflect a contemporary view that broadcasting remains more important.

These discrepancies also indicate the comparative difficulty of extending access to interactive communications, which requires links to each customer and switching facilities, compared to broadcasting, which simply requires relaying and retransmitting the signal.

(Distribution of television is difficult to isolated areas such as the interior of Vietnam and the Philippine archipelago, where satellite transmission may be the least cost solution.)

These data also indicate that a significant percentage of households in the Philippines and Vietnam has sufficient disposable income to purchase a television set, despite the very low average annual incomes. Of course, some people may place a higher priority on television as an investment for the family, as has been documented for some low income U.S. households. However, it appears safe to assume that at least as many households as those with television sets have members who would use a telephone if it were available, for example in a phone booth or at a kiosk, and that a sizable number would be able to become individual subscribers.

7. The National Flag Carrier Syndrome

The "national flag carrier" syndrome that seems to require every country to have its own airline has mutated to satellite systems. Satellites have many advantages for countries such as Indonesia and the Philippines, with archipelagos consisting of thousands of islands, and for countries such as Vietnam and other countries with very limited infrastructure and unserved rural and remote communities. However, it does not appear that demand in each country justifies its own domestic satellite system. Nevertheless, Indonesia's PALAPA system has been joined by Thailand's THAICOM and Malaysia's MEASAT, and there are two competing domestic satellites being built for the Philippines. These systems are being designed with regional beams so that they can provider services to their neighbors, but the neighbors seem intent on procuring their own satellites. Capacity is also available from regional and international systems including AsiaSat and PanAmSat, as well as INTELSAT.

The satellite policy environment in the Philippines in 1996 is remarkably similar to the situation in Indonesia in 1976. President Suharto wanted PALAPA to be launched before the 1976 elections; design and construction were constrained to meet this deadline. President Ramos has stated that he wants a Filipino satellite in orbit in time for the APEC meeting to be held in the Philippines in late 1996. At present, twocompeting systems are being built to serve the Philippine market.

The Philippines is already using satellite technology for domestic services by leasing capacity on Indonesia's PALAPA system. One argument given for investing in a Filipino satellite is that it would help reduce the national balance of payments deficit at a faster pace since scarce foreign exchange would not longer be needed for foreign transponder rental.[12] However, these systems themselves represent an enormous investment of hard currency, as domestic satellite systems (including the satellite, launch, insurance and master control stations) typically cost about $200 million.

8. Controlling Access to Information

8.1. Letting in the Flies

Chinese economic reformer Deng Xiaoping voiced his ambivalence about opening China's doors to the world: "When the door opens, some flies are bound to come in."[13] Chinese government attempts to control access include banning satellite antennas, blocking access to Internet sites, and impeding access to the Internet itself and to other means of electronic communication. Other Asian countries appear to share these concerns that information from outside will contaminate their country, even as they encourage investment in information infrastructure.

Singaporeans are not allowed to install satellite terminals to receive television from AsiaSat, Malaysia's new MEASAT, or other satellites with footprints covering Singapore, even though it has attracted uplink operators that transmit many of these channels from Singapore. Singapore is also anxious to promote Internet access as part of its IT2000 strategy, but wants to know who is using the Internet and what information is being accessed. Customers must provide their ID number or passport number to get an Internet account. The government has recently decided to apply the standards of broadcasting content to the Internet, holding Internet access providers accountable for information on their networks, and blocking access to Internet sites deemed unsuitable for Singaporeans. Such policies would seem paradoxical for a country that has staked its economic future on becoming an information-based economy.

Malaysia has also identified telecommunications as central to its goal to becoming a developed country by the year 2020. A fiber backbone now runs the length of peninsular Malaysia along its motorway; Malaysia now has its own domestic satellite system, and an "intelligent town" is being constructed on the outskirts of Kuala Lumpur. Yet the Malaysian government remains concerned about content that its citizens may find on the Internet and other satellite systems. Satellite antennas had been officially banned, although the government has turned a blind eye in rural areas and in east Malaysia (Sarawak and Sabah) where thousands of mesh antennas are pointed at Indonesia's PALAPA satellite. Now that MEASAT has been launched, Malaysia's solution is to limit sales to 60 cm. antennas, with the assumption that the equipment will only be able to pick up signals from the high powered MEASAT system.

Such policies would not be surprising, perhaps, among countries with less developed economies or less entrepreneurial citizens. Of course, Singapore and Malaysia have found that it is virtually impossible to keep out information, whether by banning certain magazines and newspapers or banning access to Internet sites and satellite channels. Yet their commitment to a policy of control seems directly at odds with industrial policies designed to upgrade their telecommunications infrastructure and attract more high tech and information-based industries.

8.2. New Technologies: Access or Control?

As cable entrepreneurs are well aware, the advantage of cable is that it allows the owner to control access to the television channels, which can be received only upon payment of a fee. Of course, cable distribution can also be monitored, so that the government will know what content is being transmitted. Thus cable TV (whether delivered via coaxial cable or optical fiber) may be considered a much safer way to satisfy demand for entertainment than uncontrollable access to satellite channels. Again, Singapore and China seem to be following a similar path. Both are spurring investment in cable systems as a means of satisfying demand for more channels stimulated by satellite television, but monitoring content. ST is also planning to invest in fiber to the flat, so that it can deliver high bandwidth Internet access and video on demand. Fiber to the home has the advantage of both supporting the "intelligent island" policy while at the same time offering the capability to monitor content and control access.

Satellite television is widely available throughout the region, most notably via AsiaSat, but also on other national and regional satellites such as Indonesia's PALAPA, Thailand's THAICOM, Malaysia's new MEASAT, and PanAmSat. Countries larger than Singapore are already unable to enforce bans on satellite antennas; controlling access will be more difficult as signals on new high powered satellites can be received with easy-to-hide wok-sized antennas. An alternative solution is to precensor programs so that only those deemed suitable are delivered by satellite. Eager to reach Asian markets, satellite programmers are willing to comply.

Ironically, video compression technology, which has been introduced for U.S. DBS services to deliver more channel choices than are typically available on cable, now provides a cost-effective means to limit choice by distributing precensored programming. Networks with regional uplinks in Singapore, for example, can digitize programming, add subtitles or soundtracks in different languages, edit out material deemed offensive by various national governments, compress the channels, and transmit several versions of the same program on a single transponder. The decoders sold in each country will be programmed to allow reception of only those channels approved by its government.

Many westerners are also searching for technological means to counter the proliferation of content they consider offensive such as violence, pornography, ethnic or racial slurs, or instructions on making bombs. The new U.S. Telecommunications Act includes provisions for a "v chip" to be installed in television sets that would enable parents to block access to offensive programs or channels. New Internet software contains "network nannies" that can be set to block access to Internet sites. Yet, unlike the policies adopted in several Asian countries, these approaches put the power of the technology in the hands of the individual, rather than the state.

9. The Challenge of Change

The Southeast Asian countries reviewed in this paper have introduced policies to increase access to information and telecommunications services throughout their countries and to strengthen their own telecommunications and information technology sectors. Some have invoked industrial policies that set specific goals and involve their governments directly through research, funding and ownership of operators. Privatization and liberalization are being introduced often as a result of external pressures, but are generally now seen as elements in their overall economic development strategies.

Yet many challenges remain for countries with more and less developed economies, and with varying models of organizing their telecommunications sectors. Separating policy and regulation from operation must mean more than changing names and separating offices. Introducing competition requires setting and enforcing the rules of the game in interconnection, settlements, and standards. Extending service to rural areas will increasingly require incentives rather than subsidies.

Perhaps more significant is the reluctance of many Asian countries to acknowledge that the inevitable result of investing in information infrastructure is to increase access to information.[3] It will be the sharing and utilization of information, not the mere existence of networks, that will contribute to their future development.

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[3] Of course, Hong Kong is an exception, having taken a market-oriented approach to opening its telecommunications sector, and generally following British norms of freedom of expression. Yet the Chinese shadow looms over Hong Kong, as Hong Kong reverts to China in 1997.

NOTES

1. Ure, John, ed. *Telecommunications in Asia: Policy, Planning and Development*. Hong Kong: Hong Kong University Press, 1995, p. 31.

2. ITU, *World Telecommunication Development Report*, 1994, p. 38.

3. "Hong Kong." *APT Yearbook 1995*. Bangkok: Asia-Pacific Telecommunity, 1995.

4. Hukill, Mark A. and Jussawalla, Meheroo. "Trends in Policies for Telecommunications Infrastructure Development and Investment in the ASEAN Countries." Honolulu: Institute for Communication and Culture, East-West Center, 1991, p. 7.

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6. Interview with DGPT, Hanoi, April 1996.

7. Interview with Consumers Association of Penang, March 1996.

8. Personal interviews, Manila, June 1996.

9. *APT Yearbook 1995*, p. 401.

10. Ure, p. 71.

11. Ure, pp. 71-2.

12. *APT Yearbook 1995*, p. 404.

13. Schwankert, Steven. "Dragons at the Gates." Internet World, November 1995, p.112.

Global Wireless Network
Based On AMPS Standards:
A Migration Study and an Architecture Review

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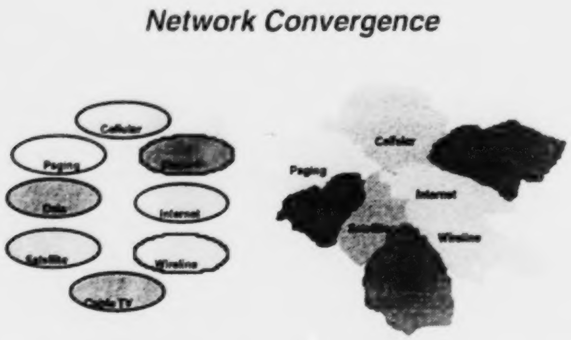
SUMMARY: AMPS represents the largest portion of the worlds cellular users. Operators' interest to network this subscriber base has increased steadily during 1996. This interest has created a strong platform for industry groups such as CTIA's IFAST and the CDMA Development Group to work on the business and operational aspects of implementing these networks into a global network. The paper reviews the issues for creating large cellular networks based on AMPS and CDMA access technology.

1. INTRODUCTION

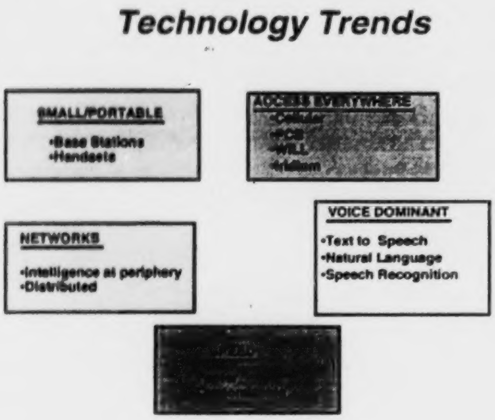
First in this paper is a brief overview of the trends in the wireless access networks. Network convergence has been a key goal in the industry for some time and it was a key theme at the ITU Telecom Geneva Show in October of 1995. As figure 1 depicts, these differing services are now starting to support each other and are actually cooperating in bundled service packages in some areas.

Figure 1: Network Convergence


Network Convergence
Cellular
Paging
Data
Internet
Satellite
Wireline
Cable TV
Cellular
Paging
Internet
Wireline

The technologies represented in this figure are certainly moving forward. As can be seen from figure 2, there are several areas that are enhancing their usefulness. Handsets are getting smaller, smarter and easier to use. The alternative services are increasing and there will soon be satellite access as an option through systems like Iridium. The network intelligence is increasing, although it is still mainly voice transport that these networks address.

Figure 2: Technology Trends


Technology Trends
SMALL/PORTABLE
•Base Stations
•Handsets
ACCESS EVERYWHERE
•Cellular
•PCS
•WLL
•Iridium
NETWORKS
•Intelligence at periphery
•Distributed
VOICE DOMINANT
•Text to Speech
•Natural Language
•Speech Recognition

2. ENDUSER NEEDS

When we build these networks we need to maintain a perspective on what the end user expects. The expectations of the enduser and the service potential should drive the architecture requirements. We can divide the end users needs into different categories.

In control, which is aimed at the productivity dependent segment. Some of the functions that operators already are providing are:
Call screening, abbreviated dialing, voice activated dialing and customer friendly billing statements.

Another growing segment is the information services area. **In touch** depict the entry of wireless into major mass marketing, some of the functions are basic cellular, single number services and messaging.

Also, there are needs that can be categorized as payment control, security and health alerts, see figure 3.

Figure 3: Subscriber Domain - Needs

BEST COPY AVAILABLE

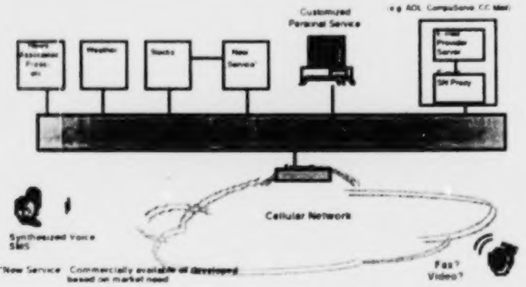
Subscriber Domain - Needs

- **In Control**
  - Call Screening
  - Abbreviated Dialing
  - Speech Recognition aids
  - Easy Bills
- **In Formed**
  - Information Services
- **In Touch**
  - Basic Cellular
  - Single Number Services
  - Messaging
- **In Funds**
  - Affordable
  - Pre-paid
  - Calling party pays
- **In Health**
  - 911/Emergency
  - Health Alert

Another area of convergence is the interconnection between cellular networks and the ever-growing Internet for provisioning mobile information services. An application of this service is Internet for CDMA phones.

Figure 4: Wireless Internet Services

INFORM - Wireless Internet Services


Customized Personal Service
e.g. AOL, CompuServe, CC Mail
Weather
Stocks
New Service*
SM Proxy
Cellular Network
Synthesized Voice SMS
*New Service: Commercially available or developed based on market need
Fax?
Video?

All these services require an efficient network architecture support for speed of delivery of call and messages as well as flexibility in interconnection between differing types of telecommunications infrastructures.

3. HOW TO BUILD LARGE MOBILE NETWORKS

The following are some of the key general principles for telecommunications networks. Increasingly, these networks are becoming dependent on a distributed network architecture. It pays off to define what is meant by distributed architecture.

DISTRIBUTED NETWORKS: ARCHITECTURE REQUIREMENTS

- UNIQUE NETWORK IDENTITY

The subscriber or terminal needs to have a unique network identity. This is especially critical in wireless as the terminal is mobile. As the terminal moves around, the network must know which terminal it is communicating with in order to keep continuity in service. An example of this is the risk of having two terminals with the same identity but with differing service capabilities.

- UNIQUE NETWORK ADDRESSING

There is also a need for unique network addressing , address in this case means actual phone number. (Note that a terminal identity and phone number can be different numbers, the phone number is what the operator assigns to the terminal identity.)
This essentially requires that operators maintain uniqueness in the numbering plans to avoid overlap in subscriber numbers. With the growth of mobile subscribers this has become an issue for international roaming where old number series inconsistent with industry plans overlap between countries.

- UNIQUE IDENTITY AND SERVICES RECORD

The subscriber needs to be represented by one unique record. This is the record where we keep subscriber profile information like services ordered, services allowed etc. Having several records for the same terminal or subscriber in the network causes information management problems and service inconsistencies.

- GLOBAL VERSUS LOCAL TRANSACTIONS MANAGEMENT

From a network point of view the interconnection of converging systems places an interesting test on how to treat global versus local transactions' management. With transactions is here meant the messaging going on for mobility management, service support and other non-basic call control messaging. Local transactions are the transactions that can be handled by the network nodes that are closest to the end user at the time of service. For the most part a highly distributed network requires frequent transactions to be done locally while transactions that require both central and local actions to be handled in a global way. A key effort is to minimize the amount of global transactions that need interaction between nodes in diverse areas of the network. If all actions are global then the distributed network architecture is not used efficiently.

- SUPPORT INCREMENTAL LOGICAL GROWTH

We would also like to see support for incremental growth per functional element so we can dimension per local need and not be dependent on actions in other nodes. This means that it is better to have logical separation between nodes so each function can be optimized per its own needs.

- MINIMIZE NETWORK OUTAGE

Another key area is to minimize the outage risk of the network by distributing network control into units of higher redundancy and less catastrophe exposure. It is quite reassuring to see the excellent performance of wireless cellular networks in times of earthquakes, major power outages, typhoons and other acts outside of human control.

The mobility networks need to apply these distributed network principles. Additional requirements for wireless networks are listed in figure 5. An expanded description of these requirements follows.

Figure 5: Mobility Network Principles

{ EMBED Word.Picture.6 }

As mentioned before the mobility networks need to ***apply the distributed network principles*** as mobility networks are essentially an extended distributed network.

To ***minimize transaction delays*** means that the network should transport messages as fast as possible throughout all the network layers. This places a real-time requirement on the communications protocol. An example of this is that a subscriber is not likely to wait five seconds to see if the network will be able to act on a service request.

We would also like to ***access network intelligence as early as possible*** in the network. This means that we would like to act on service functions with as much information as possible directly and prioritize the services based on knowing as much as possible about the subscriber. The mobile networks provide an excellent information opportunity as the networks not only knows when the subscriber turns its phone on but also periodically gets updates of the whereabouts of the subscribers. This is done through a function called autonomous registration which is built into the phones.
This is an interesting area when it comes to convergence between the wired and wireless networks. An example of this is for one-number services where the call will be delivered faster to the subscriber if we route first to the mobile phone instead of to the PSTN office or home number. Since we know whether the mobile phone is on or responding in instants we can complete the call faster than if we had routed to the office or home phone and waited for the ring-out.

As it is beneficial to use as much intelligence as early in the call process as possible it is of interest to ***place mobility dependent transactions mechanisms highest in the network***.. Some of this work has been done in the U.S. network model identifying the interfaces between local offices and mobile networks. The mobility nodes such as MSC's (Mobile Switching Centers) are now treated with the same level of priority in the network while in the older models the mobile systems nodes were one layer under the local offices.

We also need to ***plan for the duality of mobility***: The basis for all mobility is that a subscriber is no longer "home" anytime. Home here meaning a fixed physical location such as a home line. The mobile subscriber now has a home record in a Home Location Register (HLR) but the actual service transaction is always taking place somewhere else, in the serving Mobile Switching Center. This duality of "home-away" is typically not part of the planning of so-called legacy networks such as PSTN where the subscriber transactions are fixed in one node connected directly to the subscribers phone line. This duality especially adds requirement to the mobility management protocols.

Another interesting area is the issue of ***connection less versus connection oriented signal transfer***. Connection oriented meaning a requirement to know the signaling path between two interacting nodes such as a node providing a specific service and a node handling the actual access to the subscriber. A connection less orientation allows the signaling network to transport the message parts to be transported as efficently as possible in the network without the nodes knowing the actual path.
There may not be a unique answer to this question, there is however a need to consider interconnectability between mobile system of somewhat high intelligence and legacy based systems that may have a lot of information that is needed in order to meet the subscriber domain requirements as defined earlier. Generally speaking, any mobility dependent transaction is better served by a connection-less signal transfer as the network will be able to handle this function using all the benefits of a distributed architecture. The mobility real-time requirement is to have messages routed the fastest way in the network, while not loading down the global network. For the information part, there may be efficiencies of the nodes being in a more direct connection, these services also can be differentiated by tariffs to offset the less efficient way of using the signaling network.

Important is also to provide for ***separation of regional units for survivability***. What is meant by this is that local or regional nodes should be able to operate without strong dependency on actions in other nodes. This became an issue in the early nineties when a major network in the U.S., suffered a severe outage due to a software error that propagated in the network, bringing down most of the transactions management nodes. An example for mobility networks is avoing the need to update the numbering plans for each local node whenever new subscribers are added in any local node around the world.

One could put a question mark after ***hierarchical*** for the issue of ***addressing structure***. Addressing being actual subscriber phone number. The telecom industry has been increasingly shying away from hierarchical solutions in the last decade and a half. As an example, dynamic network routing solutions seem to be generally more efficient than strict hierarchical ones.

Clearly with hierarchical addressing, it is more efficient to do the address translation on the network layer as the local nodes then only need to know its on number translation.

What if we did not use hierarchical addressing? Lets define what is meant by hierarchy. Typically the industry is using a geographic representation such as home phone line by street address, this geographic representation is then placed in a hierarchy of four to five network layers of routing and address analysis. This is obviously not a general criteria for mobility-oriented networks as they do not have a fixed line geographical representation.

An alternative to hierarchical or geographic addressing would be to do application based addressing, a mobility-oriented network could use specific addressing schemes that are not tied to the PSTN's geographic addressing principles. Some parts of this are essentially in place in the countries that use pre-fix identification of mobile users such as the early 010 prefix in Sweden for NMT mobile phones.

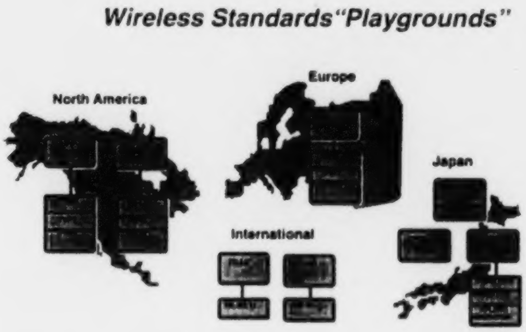
There are more examples of application oriented addressing following in the paper.

For the most part general solutions based on industry standards and administrative agreements is what will be applied globally. The next section is a review of some of these standards environments and activities.

4. Key Industry Forums And Activities For International Wireless Network Standards

Following is an introduction to some important industry forums and standards that help us in the efforts to make large networks work.

Figure 6: Wireless Standards "Playgrounds"



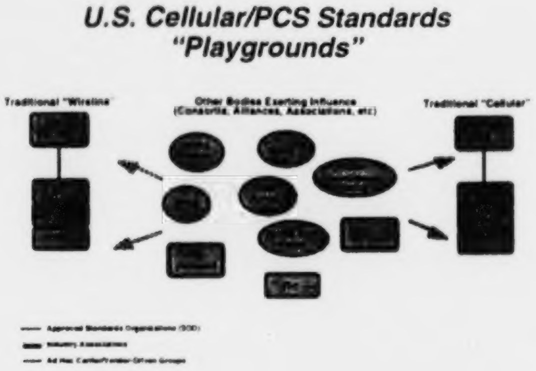
International Telecommunications Union (ITU) is providing global numbering plans for both fixed and mobile networks. It is also providing standardization of Internationally accepted access methods for mobile networks in its recommendation M.1073.

Telecommunications Industry Association (TIA) and the T1 committees in the U.S. are providing standards for mobile technologies. These groups work as accredited American National Standards Institute (ANSI) forums for setting standards.

And in Europe we have the European Telecommunications Standards Institute (ETSI).

The Japanese standards institutions as well as the Korean ETRI have been increasingly active in global standards activities lately.

Figure 7: U.S. Cellular and PCS Standards "Playgrounds"


U.S. Cellular/PCS Standards
"Playgrounds"
Traditional "Wireline"
Other Bodies Exerting Influence
(Consortia, Alliances, Associations, etc)
Traditional "Cellular"
Approved Standards Organizations (SDO)
Industry Associations
Ad Hoc Carrier/Vendor-Driven Groups

In the U.S. there has been a significant addition to the industry working groups due to the growth of PCS activities. The CDMA Development Group (CDG), the North American PCS Action Group (NPAG) for PCS 1900 GSM and Cellular Telecomunications Industry Association (CTIA) are all active in PCS industry issues. CTIA has initiated the International Forum for AMPS family of Standards Technologies (IFAST), which is to make the AMPS family of standards interconnection more practical.

IFAST is a very important forum for international recommendations and will be covered later in this paper.

5. REFERENCE ARCHITECTURES AND SIGNALING PROTOCOLS

Reference architectures are important as a base for the interconnection specifications. A reference architecture defines the key interfaces in the distributed and open network architecture.
Here are some of the industry's most important reference models. From a wireless point of view the ANSI/TIA model and the ETSI GSM network reference models are the most interesting.

Figure 8: Reference Architectures

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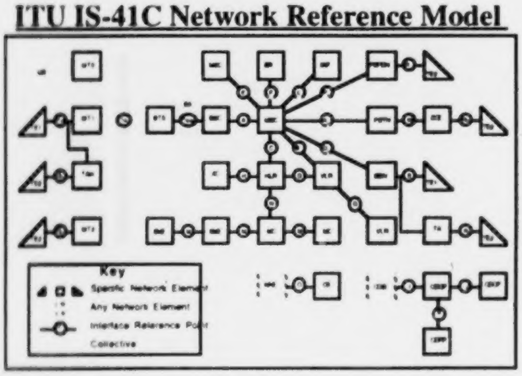
REFERENCE ARCHITECTURES

- **ISO/OSI**
- **ANSI/TIA CELLULAR NETWORK**
- **GSM CELLULAR NETWORK**
- **UMTS/FPLMTS**
- **B-ISDN**
- **ITU-T IN NETWORK**

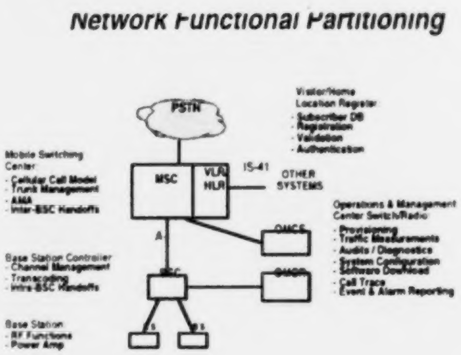
In figure 9 is an example of such a reference architecture, this is the ITU IS-41 C reference model.

FIGURE 9: ITU IS-41 C Reference Model


ITU IS-41C Network Reference Model
Key
Specific Network Element
Any Network Element
Interface Reference Point
Collective

Another way to depict the reference model is shown in the following figure. Here the key interfaces, IS-41 (the intersystem mobility protocol), A+ (the open base station interface), and the PSTN interface are shown, as well as the main functions of the different nodes.

Figure 10: Network Functional Partitioning


Network Functional Partitioning
PSTN
Visitor/Home Location Register
- Subscriber DB
- Registration
- Validation
- Authentication
Mobile Switching Center
- Cellular Call Model
- Trunk Management
- AMA
- Inter-BSC Handoffs
MSC
VLR
HLR
IS-41
OTHER SYSTEMS
Operations & Management Center Switch/Radio
- Provisioning
- Traffic Measurements
- Audits / Diagnostics
- System Configuration
- Software Download
- Call Trace
- Event & Alarm Reporting
A
Base Station Controller
- Channel Management
- Transcoding
- Intra-BSC Handoffs
Base Station
- RF Functions
- Power Amp

MOBILE APPLICATION PARTS

An interesting part in reference architectures is the evolution of Mobility Application Part (or protocol)

(MAP). The MAP is the top layer applications protocol that provides the actual mobility service support in a mobile system. The early eighties gave us the Nordic systems mobile user part which was later amended separately by the hand off user part.

Some of the proprietary application parts developed in the latter part of the eighties (Autoplex, DMX, MTUP) have been very important in formulating the current IS-41 and GSM mobile application parts. The IS-41 MAP is the AMPS family of standards mobility application part as defined by TIA while GSM uses the ETSI defined GSM MAP. Other activities in the application part area are Wireless IN (WIN) and CAMEL. See the following sections. WIN and CAMEL are ANSI's and ETSI's respective efforts to make the mobile application parts more IN (Intelligent Network) friendly. UMTS and FPLMTS are driving network and access issues towards the next generation of wireless networks.

MESSAGE TRANSPORT PROTOCOLS

Currently we can choose between X.25, ITU-T C7 and ANSI SS7 as transport for mobility protocols. All of these protocols are currently in use in commercial mobility networks. We will likely see X.25 go away as it is being replaced by either of the two common channel signaling protocols.

A key requirement on message transport protocols is local access availability. Local access availability requires that the networks have a reasonable commercial availability in major population areas otherwise the distribution of the network functions will be hampered.

Control system orientation is also required which means that the transactions management is there to control the resources of the service providing network.

New transport methods in the future may include ATM, broadband SS7, and the Internet protocols. Interconnection between the current systems and these new methods will be an important task for the standardization areas.

The Internet is an interesting subject due to its tremendous growth. Actually Internet emulates much of the MAP functions in cellular although it was not initially designed for mobile hosts. Internet has an interesting character of doing addressing in a non-geographical fashion. There certainly are some delay issues though that need to be reviewed which anybody surfing the web knows.

ITU C7 SIGNALING SUPPORT AND IS-41

The ITU signaling transport supports the IS-41 mobility protocol that permit cellular systems using air interfaces such as AMPS, TACS, TDMA (TIA IS-54 and IS-136) and CDMA (TIA IS-95) to support large networks with millions of subscribers. The first networks where IS-41 provided multi-million subscriber networking was in the U.S. in 1991.

Specifically, IS-41 functions provides procedures that detect the presence of a mobile subscriber in a visited system and also validates a subscriber for service. This is done in order to allow access to subscribed services while roaming outside the original service area.

The IS-41 standard is similar to ETSI's GSM MAP standard and has similar functionality for mobility management. The network reference models are also quite similar as can be seen from figure 9.

The international use of ITU's Common Channel Signaling System #7 (C7) provides a high-speed, reliable means of communicating mobile call control and mobility management information (caller location, routing of addresses, subscriber categories etc.) between switching systems. The design of the C7 utilizes the ITU open network architecture layered approach, the Open Systems Interconnection (OSI) oriented layers and applications.

The open system interconnection reference model defines several layers of transport, routing and applications. We are specifically interested in the MTP layer 3, the SCCP, the TCAP and MAP. Message transfer part (MTP) ensures that all messages are transmitted error-free and in the correct sequence.

Signaling connection control part (SCCP) manages signaling information about circuit status and other information regarding location, billing and services. Transactions capabilities application part (TCAP) defines the protocol that transfers vital information between control segments of the cellular network. The TCAP is specifically useful for non-call related signaling which is needed for mobility support in cellular networks. The TCAP use in IS-41 is quite intrinsically defined with the mobile application part which is why the industry is using the ANSI TCAP.

Mobile application part specifies the transfer of non-circuit information between mobile switching centers including location updating and roaming, hand-off, user authentication, and other service related transactions.

6. ADDITIONAL NETWORK STANDARDS

This section is a brief overview of some new standards in the wireless industry that will be of use in providing new services.

IS-124 DMH

IS-124 DMH specifies a protocol for near real-time exchange of call detail records (CDR) over a data network. This is a unique effort that is not available in the ETSI/GSM specifications. IS-124 is also called Data Message Handler (DMH). IS-124 provides information for timely billing of mobiles, net settlement between operators and fraud management. The official TIA project was established in 1992 and an initial issue balloted in November, 1993. Revision A was balloted in July, 1996.

WIN

WIN is a service-independent architecture which is greatly enhancing existing capabilities in wire-line networks while being based on standard service-independent interfaces. It is oriented towards a migration from MSC-centric architecture which is intended to create a focus on rapid deployment of new services that will permit operator differentiation of services.

The objective of WIN is to standardize the interfaces between platforms and the mobility call models. WIN will allow multiple points of service control to be done either in the SSP, the SCP, the HLR or in the Service Node.

WIN & IS-41

With this IN orientation, we can extend IS-41 to support new services by using an initial set of triggers for WIN. There is work ongoing in TIA defining new interfaces to other network entities such as Service-Node and Intelligent Peripherals.

The foundation for WIN is already in place in the form of the triggers in IS-41 revision C.

7. NUMBERING AND NETWORK ADDRESSING PLANS

The worldwide numbering plans are boundary requirements for the mobile networks to work efficiently. We have quite a few plans to be concerned about. E.163 is the base PSTN numbering plan while E.164 is the Directory Number (DN) plan. The one that the mobile industry is most interested in is the E.212 plan, which is the International Mobile Station Identity (IMSI) numbering plan. This is a non-dialable number which defines the IMSI for identifying a mobile terminal. IMSI is a 15-digit number. All these plans base the layers on geographical difference where the first layer with one recent exception has been representing the country code only.

The recent exception is the satellite mobile service Iridiums own country code for number addressing. ITU has recognized the need for an applications based number plan for Iridium and applied a specific country identity to Iridium in its numbering plan.
There is a need to review the current addressing principles and make sure that the country dependencies can be taken care of while making the mobility networks as efficient as possible.

Another important specification for the AMPS family of standards is the TIA TSB-29 (Telecommunications Services Bulletin 29) which contains several recommendations to assist the international implementations. Revision B contains recommendations in the following areas:

Mobile Identification Number tables (MIN), IMSI, Global Title Translations (GTT) types for ANSI and ITU SS7 signaling and IS-41 protocol considerations within ITU CCS #7 networks.

In the network architecture area we also need to be concerned about the importance of point code (PC) management. Point codes are used to identify network nodes. Since network nodes are somewhat fixed in our geography, it makes sense to use a geographical approach to layering.

The ITU-T's point codes are two-layered, while the ANSI pointcodes are three-layered. Pointcodes may be the next logical resource to be at risk so it may be a good idea to take a look at what next generations requirements will be in this area. Global three-layer, inter-country PC's may be needed and as mentioned before, mobile networks need to be addressed as high up as possible in the network for transactions routing to be as efficient as possible.
The Internet is as mentioned non-geographical in its addressing , however, it is only two layered in its node addressing which would make it less efficient globally.

8. MOBILE NETWORK EXAMPLES

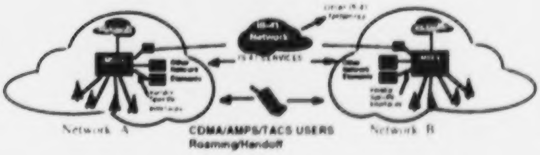
Lets take a look at how the actual mobile networks are evolving.
The following illustration shows how a typical mobile network is configured. A city or country cellular network is connected using industry standard communications protocols allowing subscribers to bring their mobile phones to different cities and different countries while enjoying fully transparent

service. This network example uses the ANSI IS-41 protocol to tie two differing networks together.

Figure 11: Cellular Networking

Cellular Networking

- **TIA IS-41 is an Inter/Intra Network Communication Protocol**
- **Developed to Support Inter- Operability Between Networks**



IS-41 is the inter-system protocol in the Chinese nationwide analog cellular network. This architecture provides roaming capability between systems in different cities and provinces. Inter-vendor roaming was put in place at the end of 1995 through IS-41 links between Motorola and Ericsson equipment based networks.

The networks meet at what has been defined as high-level STP's (signal transfer points). The STP's help in providing the network dedicated mobility message distribution and routing functions. Low-level STP's will be deployed as needed based on network architecture and message transactions capacity requirements.

The network uses the generally accepted principle of reducing the amount of STP layers in the overall network, which serves to reduce transactions delay for the various transactions transport cases. This principle was also used in the U.S. nationwide network.

The inter-system networking has created the largest nationwide roaming cellular network in the world. The inter-system networking utilizes the ITU-R recommended industry-standard IS-41 revision B. The second phase of the interconnection will feature 24 bit type addressing (MTP) China C7 as the transport layer.

NETWORK APPLICATIONS

These methods and functions are now being deployed in networks throughout the world.

The CDG's International Working Group and IFAST have been working diligently during 1996 to provide recommendations to the operators on how to migrate AMPS networks into CDMA and International Networks as well as setting up new CDMA networks using ITU IS-41 for Global Roaming. These recommendations have been included in TSB-29B already.

The CDMA PCS networks in the U.S. are already being tied together using IS-41.
International examples for AMPS networks include North America with Central America and also with Latin America. Israel is also an example of international AMPS family of technologies networking.

Asia is coming strongly with several countries such as Korea, Hongkong, Singapore and others now interacting with the U.S. in terms of AMPS and CDMA networking.

7. SUMMARY

As we have seen, large mobility networks are evolving rapidly. New architectures will be even more distributed and they will use the intelligent network architecture with new standards for convergence.The network architecture evolution is truly global and worldwide dependencies are becoming our next challenge. The mobile networks need to be planned as efficiently as possible with the least amount of restraints. There are currently several national and regional CDMA networks, that are evolving using IS-41.

ABBREVIATIONS:

AMPS	=	Advanced Mobile Phone System
ANSI	=	American National Standards Institute
B-ISDN	=	Broad band ISDN
CAMEL	=	Customized Applications for Mobile network Enhanced Logic
CCS #7	=	ITU Common Channel Signalling # 7
CDMA	=	Code Division Multiple Access
CTIA	=	Cellular Telecomunications Industry Association
DMH	=	Data Message Handler (IS-124)
ETSI	=	European Telecommunications Standards Institute
FPLMTS	=	Future Public Land Mobile Telephone System
GSM	=	Global System for Mobile Communications
HLR	=	Home Location Register

IFAST = International Forum for AMPS Standards Technologies
IMSI = International Mobile Station Identity
ISDN = Integrated Services Digital Network
IN = Intelligent Network
ISO = International Standards Organization
ITU = International Telecommunications Union
MAP = Mobile Application Part
MIN = Mobile Identification Number
MSC = Mobile Switching Center
NMT = Nordic Mobile Telephony System
OSI = Open Systems Interconnection Reference Model
PSTN = Public Switched Telephony Network
SCCP = Signaling connection control part
STP = Signal Transfer Point
TDMA = Time Division Multiple Access
TIA = Telecommunications Industry Association
UMTS = Universal Mobile Telephone System
WIN = Wireless Intelligent Network

TELKOM's Approach to Interconnect Switching Into Integrated Management System (IMS) in Broadband Era

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PT. Telekomunikasi Indonesia
Bandung, Indonesia

1. ABSTRACTS

The administration, monitoring and operations of the telecommunications network is becoming a very complex task and requires the application of network management technique to achieve optimum availability and control of the entire network. Future broadband services will introduce even more complex problems and will require even more sophisticated solutions. Although support systems for broadband have not been yet fully developed, the consideration of future implementation is considered in TELKOM's Network Management.

2. BACKGROUND

TELKOM's current operations environment consists of seven reqional division that provide local services in respective geographical regions, and a network services division that provides domestic long distance services. Of the seven region divisions, five are joint venture with international investor consortia called KSO divisions. Only Division II, V and network services are solely TELKOM operations. Even though TELKOM is part of all seven region divisions, each division operates as separate decentralized management and separate cost and profit center witth its own internal financial statements. All Divisions share repair, information services, training, propertu management, and R&D from TELKOM. The KSO divisions consist of investors from Europe, Asia, Australia, and the USA. The intent is to assimilate the strengths from diverse skills and experiences for accimplishing the large scale expansion and modernization effort.

TELKOM has a six yaer strategyc plan from 1996 to 2001. The main goal if this strategy is to reach "World Class Operator" status in 2001, and the plan is to be used as the guide in deriving annual work plan in each TELKOM division including KSO division. T-2001 project is a transformation process which is very fundamental to the working culture as well as to the course of tasks and responsibilities, especially the process which is directed to DATEL and its subordinates.

TELKOM's current network structure includes multiple type of switching systems such as electromechanical, analog and digital, combined with multiple types of transmission system (analog, digital, satellite, microwave, fibre optic and copper cable). The network is also multi vendor as well as a number of locally produced, smaller switching systems, and transmission equipment from several vendors.

With those conditions, the administration, monitoring and operations of the telecommunications network is becoming a very complex task and requires the application of network management technique to achieve optimum availability and control of the entire network.

As customer requirement become more sophisticated, Integrated Management System will become important to quickly adjust and manage the new products and services. The development of IMS capability will be influenced by development of new technology such as ISDN, CCS No.7, and broadband era.

This paper give a brief description about the problems to interconnect digital switching and the solutions taken by TELKOM. As Metropolitan Area Network is in field trial in Jakarta this year, the network management of MAN will be derscribed in this paper.

3. EXISTING NETWORK MANAGEMENT

In 1993 TELKOM adopt the Telecommunication Management Network which is expected to achieve optimum availability and control of the entire network and to have capability to monitor the performance of the entire network. The prime infrastructure of the network management function is the Integrated Management System (IMS) that is expected to be capable of achieving certain functions of the ITU-T as per draft recommendation M.3010 include fault management, configuration management and performance management.

The Integrated Management System (IMS) is centred on the National Network Control Centre (NNCC) that carries out surveillance of the overall network and transmission backbone. 5 Regional Network Control Centre (RNCC) are connected to the NNCC and carry out surveillance of switching in each region. The operating system used to integrate various type of switching is MFOS (Multi Function Operating System).

Telkom has a planning to develop IMS that has a capability to monitor and control all switching connected in the network by centralised manner through the IMS. The controlling and monitoring of switching is done using hierarchycal manner that is in local level and regional level. In this planning TELKOM should connect all switching to IMS using X.25 protocol. The problem arise in this area is how to connect all switching considering of our existing network that is comprise many types of switching.

To get solutions for both problems TELKOM take two ways approach those are short term solution and long term solution. The first solution is TELKOM made a convertion protocol for X.25 between different switching and IMS to ensure information model that flow from switching base on its X.25 protocol will have a same format with information model required by X.25 protocol in IMS. This solution will make a capability of monitoring and controlling switching done centralised through IMS. The second solution that is for the long term TELKOM will implement standard interface between various systems to create the Integrated Management System. The aim of this approach TELKOM could make as follows:

- Ensure systems are interconnectable and interoperable
- Spesify and implement standard interfaces

To achieve system interoperability, TELKOM must specify and implement standard interfaces. These will provide an organized architecture that sets the standards for interconnection and interoperability between the various operations systems and the interfaces which they support. The interface requirements should conform to ITU-T recommended standards for TMN.

Requirement for standard interfaces and precise assigments of responsibility for implementing the interfaces should be included in every equipment contract that TELKOM signs. Contracts for software should have the clauses that ensure the software purchased will not effect the interfaces.
To ensure the ongoing adherence to standards, a central standards will study and examine all standards implemented in network to insure standardization throughout the network.

4. INTRODUCTION OF METROPOLITAN AREA NETWORK IN INDONESIA

It has been a commitment of TELKOM that telecommunication development should cover not only telephone service, but also other modern services based on multimedia technology. The processes habe begun since PASOPATI was first introduced by increasing the capacity of telephone signal network system to be 64 kbps using ISDN Narrowband service.

Modernization process is continued by expanding the network infrastructure onto broadband capability. The first step has been taken with the plan to erect Metropolitan Area Network (MAN) in Jakarta for SMDS service. This will be the answer for the growing demands on high speed public data network service for LAN- to LAN application file transfer, multimedia conferencing and LAN- to Host connection services.

MAN network, which is based on DQDB technology in accordance with IEEE 802.6 standard, was chosen as a preliminary solution for the demand on broadband service in the future before ARM standard has been technically and commercially proven in a structured network evolution concept. MAN network configuration was designed on four node covering central business areas, i.e. Jakarta Gambir-1, Semanggi-2, Slipi and Kota-2.

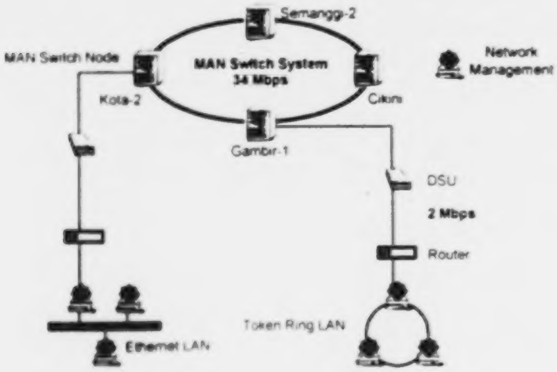
Semanggi-2
MAN Switch Node
MAN Switch System
34 Mbps
Network
Management
Kota-2
Cikini
Gambir-1
DSU
2 Mbps
Router
Token Ring LAN
Ethernet LAN

Figure 1. MAN-SMDS field trial configuration

4.1 MAN SWITCHING ARCHITECTURE

This section will describe MAN Switching architecture based on Distributed Queue Dual Bus (DQDB). Generally, architecture of MAN switching consist of 3 hierarchie, those are customer access network (CAN), MAN switching system (MSS) and interconnection between MSS. These three hierarchy is show in Figure 2.

a. Customer access network (CAN)

the role of CAN is gathering network and to concentrate traffic from customers. In this hierarchy, there is customer gateway (CGW) that connects customer to CAN and Edge Gateway (EGW) that connects CAN to MSS. CGW will multiplex traffic from customer to CAN and act as local switching within customer in CAN. Meanwhile, EGW does routing from CAN to MSS and vice versa. Beside that, EGW has function as point of tariff where operator calculates the usage of MAN network (charging).

b. MAN Switching System (MSS)

MSS performs switching of data packets from one customer to other customer. In this hierarchy, customers connect to one MSS. One MSS could consist of one or more subnetwork. In case MSS consists of more than one subnetwork, interconnection will be done by using subnetwork router (SR) that has function to route IMPDU from one subnetwork to others.

c. Interconnection between MSS

In case there is IMPDU packets that will be sent to customer in different MSS, the origin MSS will pass the packets to MSS destination through IMG (Interf-MSS Gateway) or ICI (Inter-Carrier Interface). IMG is used for MSS interconnection by the same operators, meanwhile ICI is used to interconnect MSS that operate by different operators.

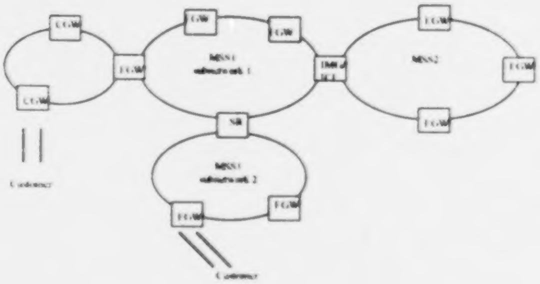
CGW
CGW
EGW
EGW
EGW
MSS1
subnetwork 1
IMG/
ICI
MSS2
EGW
EGW
EGW
SR
CGW
Customer
MSS1
subnetwork 2
EGW
EGW
Customer

Figure 2. MAN Switching Architecture

4.2 CONFIGURATION OF MAN NETWORK MANAGEMENT

The function of MAN network management is to manage the network that provides service and maintains the service level offered to the customer. MAN network management configuration could be seen below :

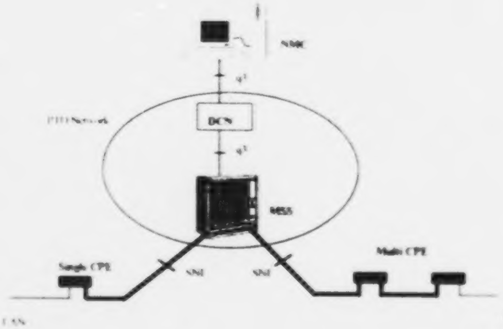
NMC
q3
PTT Network
DCN
q3
MSS
Single CPE
SNI
SNI
Multi CPE
LAN
LAN

Figure 3 MAN Network Management Configuration

a. Network Management Center (NMC)

NMC is the controlling center of MAN network management. NMC consists of OS (Operating System) and RAO (Revenue Accounting Office).

OS has function as managing system, meanwhile MSS (MSS NE, supervisory system and Gateway MSS NE) have function as managed system. OS coordinates MSS resources (physical resource and logical resource) by mean of management functions called OS application. OS can be put in center of location. Connection of OS and MSS is via DCN. NMS may consist of one or more OS that support management process from one or more MSS.

RAO performs collecting accounting data from each MSS. RAO is put beside operator and connected to each MSS through DCN. RAO just collects data and does not perform network management functions. RAO does the coordination of data accounting collection from all MSS in the network. Data collecting is done through Data Communication Network (DCN).

b. Data Communication Network

DCN is specific communication path, it could be dedicated line or dial-up line. This Communication path supports communication between MSS and OS/RAO in MAN network management process

c. Interface

Q3 interface is used to make connection between network management center (NMC) and data communication network (DCN) and between DCN with MSS. The interface between MSS and CPE are SNI (Subscriber Network Interface) and could be defined as the administrative boundary or MAN network physical boundary.

d. MAN Switching System (MSS)

MSS perform high-speed packet-switching functions (such as addressing, routing and validation) based on DQDB technology. Besides performing switching functions, MSS performs operation and maintenance functions. These functions are implemented as console and supervisory system.

- Console

  Console is input/output equipment that is connected directly to MSS NE. Through consel, operation personnel can access MSS NE directly to perform operation function such as test diagnostic, access to performance data, etc. The function of console can be done from remote location through data communication network (DCN). Interface X.25, dial up communication or other methode can be used as communication facility.

- Supervisory System

  MSS performs management functions to resource in MSS. These management functions can be implemented specifically in a system called supervisory system or can be integrated in MSS. Functions of supervisory systems are as follows : alarm monitoring, temporary data storage and function related to data provisioning. Supervisory system performs also database structure function in MSS NE.

4.3 Network Management Functions of MAN

MAN network management is done by operator (Public Telecommunication Operator - PTO). The function of Network management center (NMC) is to control operation of MAN. The function of MSS or MSS NE network management can be categorized into 5 groups, those are network traffic management, memory administration, maintenance administration, network data collection, usage measurement.

a. Network Traffic Management Functions

The functions of network traffic management in MSS is to monitor and control real time network traffic, detection of congestion, knowledge to OS and congestion control.

Congestion control is done by MSS to control traffic when congestion happened in order to keep MSS performance optimum. Congestion control by MSS consist of 2 categories, those are expansive control and protective control. Expansive control is done by moving half of traffic to other part in MSS (spare capacity). The example of expansive congestion controlling is change of routing table to avoid congestion in part of MSS NE. Protective control is done to avoid the spread of congestion, such as limitation of traffic that can be process by MSS.

b. Memory administration Management Functions

There are 2 type of Memory administration functions, those are provisioning driven function and system administration function. Provisioning driven functions is needed in cane to fulfill customer request by assigning the suitable network resource. System administration function is needed to do backup and restoration and MSS database security.

c. Maintenance Administration Function

Maintenance Administration is management function in MSS which is needed in maintenance of SMDS service. Maintenance administration consist of alarm monitoring, performance monitoring and testing.

d. Network Data Collection functions

Network data collection function is done by MSS NE to collect usage resource data in network. From this data, network traffic pattern and customer traffic pattern can be known. Each MSS NE collects network data with specific time interval. MSS NE can also collect data for specific purpose as requested by OS.

e. Usage Measurement management functions

Usage measurement management function is done by MSS to support RAO (Revenue Accounting Office) to account cost/tariff that should be paid by SMDS subscriber based on network usage intensity.

5. CONCLUSION

The solution for problem arise in TELKOM existing network management for interconnection process digital switching to IMS are carried out by two step. The first step basically base on the existing condition aims to interconnect all switching installed without specify a standard interface base on ITU-T recomendation. The objective of this step is to make every switching could communicate with IMS for transfering management information. The second step is to develop and implement a standard interface that recommended by ITU-T. This step is in accordance with the objective of TELKOM to build a platform of network management in TELKOM that will accomodate every function developed and every system installed.

As network provider, TELKOM will continue to modernize the infrastructure, evolving from narrowband technology to broadband technology. The modernization of the infrastructure will be followed by network management aspect that has very big impact in improving network performance and customer satisfaction. The implementation of Network Management for Metropolitan Area Network (MAN) is first step of moving to broadband era and it will be followed by implementation of network management of ATM in the near future.

TELKOM has chosen to base its network management evolution plan on the ITU-T TMN Recommendations. This means that TELKOM would like to realize the advantages of interoperability for management of its telecommunications equipmnet and network. The advantages include function expansion flexibility, software and hardware reusability, integrated network management, flexibility in forporating new technilogies and services. Because interoperability involves multiple systems and different suppiers, to realize the advantages, various issues and specifications need to be addressed throughout the different phases from architecting, planning, designing to requirement, development and deployment.

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Real Time Traffic Management System at Korea Mobile Telecom

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Abstract

We have developed methods that enable the determination of network traffic in real time utilizing what is presently available. These methods are based on some well known estimation methods, and the network traffic is calculated through the use of local measurements, network topology and capacity, and control parameters such as routing tables. The calculated network traffic is not just in the form of aggregate originating traffic, but we are able to determine the traffic levels for all origin and destination point pairs with surprising accuracy in a network owned by Korea Mobile Telecom. The traffic estimated enables us to monitor the network performance and to invoke different types of control to the network to improve the performance according to the arriving patterns of call request.

1 Introduction

Wireless technology and high speed electronics have revolutionized the telecommunication industry in recent years. We now have the technology necessary to provide a variety of services that are not restricted by the mobility of users. While there is over one hundred years of experience in the telephone networks, there remain many unknowns about the wireless networks with mobile traffic. When high demand is combined with extremely dense terrain and population profiles, it is critical to understand the network traffic characteristics (e.g., where to where, and slow vs. fast mobility) as a basis for network control such as routing and cluster partitioning in order to best utilize the available network resources.

One of the most important tasks in the network management is understanding the characteristics of network traffic, especially the intensity of exogenous traffic for each origin-destination(OD) pair. Once the exogenous traffic intensity is known accurately, it is possible to invoke different types of control to the network to improve the performance according to the arriving patterns of call request. Collection of such functions are known as the demand servicing. The demand servicing is a process that typically takes place at intervals of few seconds to several days, and involves reconfiguring the network resources to accommodate continuous variations in the traffic patterns. The demand servicing plays a particularly important role during the introduction of new services. During the introduction, the demand level for a new service may fluctuate vigorously and the exogenous traffic intensity then becomes critical information in tuning the performance of the network. The intensity of exogenous traffic is a critical input to a variety of other network functions, including routing, cell clustering, switch clustering, and network capacity planning. Once the current exogenous traffic intensity is known, based on this value, one projects the traffic level expected for the future, and in turn calculates the capacity requirement for all elements of the network. Subsequently the capacity of the network is augmented and the clustering of cells and switches is re-configured to satisfy a specified grade of service such as the overall blocking probability and the call drop rate. Unfortunately, however,there is no direct way of measuring user-generated network traffic in real time. What is available instead is a collection of local measurements (typically at switches and trunks) that describe the utilization of isolated equipment and facility. Using the measurements, the point-to-point traffic can be estimated by various methods as described in [6].

A typical wireless network consists of the Mobile Switching Center(MSC), the Base Station(BS), the Mobile Station(MS) and the Public Switched Telephone Network(PSTN) [3]. In an MSC, one or more Digital Cellular Switches (DCSs) may exist with a processor that controls the call carrying process.

Some MSCs may not contain this type of processor, in which case the DCSs in these MSCs will be controlled by a processor located in a nearby MSC. A BS is also known as a Cell Site where radio transmitter and receiver are located. An MS is essentially a mobile unit that each subscriber needs to carry. The PSTN is needed to provide connections between the land subscribers and the mobile units.

Traffic patterns between all origin-destination (OD) pairs are determined from the measured trunk and cellular data. OD pair traffic patterns which pair different levels of network elements (i.e., Cell-to-Cell, DCS-to-DCS, and ECP-to-ECP) are evaluated. To specialize the above description to the case of our study involving a network owned by Korea Mobile Telecom (KMT), the MSCs are based on the Autoplex (APX) technology, a type of DCS manufactured by AT&T. The essential components of this MSC are:

- **APX:** 3 staged (i.e., Time-Space-Time) digital circuit switching device with virtual nonblocking property. The time stages employ the time slot interchangers (TSI) and the space stage is a time multiplexed space (TMS) switch. APX can be engineered modularly. APX is derived from AT&T 5ESS which had been developed in early 1980's.

- **Executive Cellular Processor (ECP):** The ECP controls the call carrying process of the APXs. A number of APXs can be served by a single ECP. ECP is UNIX based and is also responsible for system maintenance, voice channel administration, system initialization, billing data collection and performance measurements.

- **Interprocess Message Switch (IMS):** The IMS is a shared medium multiple access packet switch that oversees the transmittal of packet units to various peripheral devices in the ECP complex. IMS is a ring structured device with one or more Ring Peripheral Controller Nodes (RPCNs). RPCNs control the packet transfer in the IMS ring using a well known token generation method. Also attached to the IMS ring are the Call Processing and Data Base Node (CDN), Cell Site Node (CSN), and Digital Switch Node (DSN).

Routing policies [5] are one of the critical factors that determine the network performance. We study the impact of routing policies on various aspects of network performance, such as the utilization of the transport network and the call processing capability. The KMT's network has the patterns of ECP clustering, which may impact the utilization of the IMS Ring which is critical in the information processing and the control capacity of the ECP complexes. The efficient clustering needs to be determined through the investigation of the OD pair traffic patterns. The IMS Ring utilization is analyzed under the known point-to-point traffic patterns. The connection patterns of the DCS's is also studied to quantify the impacts of ECP clustering while these factors need not be monitored in real time. Overall blocking performance of the network is quantified for various levels of aggregated sources (i.e., cell, DCS, and ECP).

The paper is organized as follows: In Section 2 the traffic model and the mathematical description of the point-to-point traffic estimation methods are given. Section 3 describes the ECP clustering and signaling traffic and Section 4 introduces our simulation tool. The numerical results is given in Section 5 and finally, the conclusions is in Section 6.

2 Traffic Models and Point-to-point Traffic Estimation

Recalling the call set up process described in Section 3, there are different levels of aggregated traffic one may consider. Since one set of the available data is from trunk measurements in the transport network, from this, we can calculate directly the OD pair traffic between each pair of DCSs in the network. By aggregating the result of this exercise, we can also calculate the OD pair traffic between each pair of ECPs. Now using the fractional intensity of the cellular measurement data, one can interpret the OD pair traffic between each pair of cells. Finally, using the seizure success statistics, the OD pair traffic between each pair of mobile user groups. The relationship between the different types of OD pair traffic is visualized in Figure 1.

The methods of exogenous traffic estimation are described in [6] in great details. Here we describe only the introductory part of it. Exogenous traffic enters the network as independent Poisson streams, one for each OD pair belonging to $\mathcal{P}$. Let the intensity of the Poisson process corresponding to OD pair i be denoted as x_i calls per time unit. The x_i, $i = 1, 2, 3, ..., P$, are unknown parameters. The $PACE$ reports the measured statistics during each hour. During each one-hour measurement period, we have a set of observations, (y_k, a_k, o_k), for each link k of the transport network, and based on this and on our knowledge of the routing sequences R_i, $i = 1, 2, ..., P$, we would like to estimate the exogenous traffic intensity x_i, $i = 1, 2, 3, ..., P$.

First, we examine the relationship between the

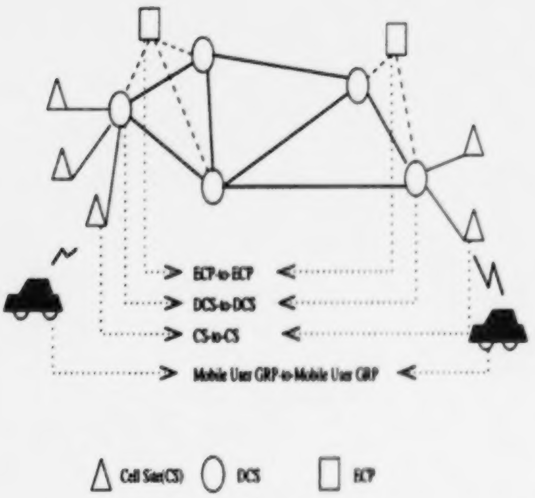

Figure 1: Different Types of OD Pair Traffic

x_i's and the (a_k, o_k). The number of calls, a_k, which arrive on link k, could have originated from various OD streams. However, there are only certain possible realizations, n_i, $i = 1, 2, ..., P$, of the actual number of arrived calls in Poisson stream i which are compatible with the observations (a_k, o_k), $k = 1, 2, ..., L$. If the n_i, $i = 1, 2, ..., P$ are known precisely, then by the independence of the exogenous Poisson arrivals, an excellent estimator for the exogenous traffic intensity for OD pair i would be n_i/t. (t is the measurement interval.) For instance, it is the maximum likelihood estimator. Therefore, we first consider the problem of estimating n_i, $i = 1, 2, ..., P$ from (a_k, o_k), $k = 1, 2, ..., L$.

We define the following variables: let route variables r_{ij}, $i = 1, 2, ..., P$, $j = 1, 2, ..., M$, denote the number of calls blocked in route ij out of the calls offered between OD pair i. Define link sets $W_k(m)$, $k = 1, 2, ..., L$, $m = 1, 2, ..., M$, such that

$$W_k(m) = \{i \mid \text{link } k \text{ is part of route } im\}.$$

In order to acquire facility with this notation, note that, since all routes are limited to at most two links, any link k is either $im1$ or $im2$. It can be easily shown that the cardinality of $W_k(m)$ is upper bounded by $2N - 3$.

From our formulation, if $i \in W_k(1)$, n_i calls between OD pair i are offered to link k which is part of the first choice of route. Also, the calls that are rejected from other routes are offered to link k. Hence the total number of calls, a_k, which arrived at link k can be expressed as

$$a_k = \sum_{i \in W_k(1)} n_i + \sum_{m=2}^{M} \sum_{i \in W_k(m)} r_{im-1}.$$

Also, we know that the number of overflow calls, o_k, must satisfy,

$$o_k = \sum_{m=1}^{M} \sum_{i \in W_k(m)} r_{im}.$$

Thus the number of calls, n_i, which actually arrived in Poisson stream i must be a solution to the following system of linear inequalities:

$$\begin{aligned} a_k &= \sum_{i \in W_k(1)} n_i + \sum_{m=2}^{M} \sum_{i \in W_k(m)} r_{im-1}, \qquad (1) \\ o_k &= \sum_{m=1}^{M} \sum_{i \in W_k(m)} r_{im}, \\ n_i &\geq 0, \\ r_{ij} &\geq 0, \\ k &= 1, 2, .., L, \quad i = 1, 2, ..., P, \quad j = 1, 2, ..., M. \end{aligned}$$

Any integer-valued solution to the system of linear inequalities (1) results in a set of possible OD pair arrivals, n_i, $i = 1, 2, ..., P$, that are consistent with the observations, (a_k, o_k), $k = 1, 2, ..., L$. Since the observations arise from the actual physical processes in the network, we know that there exists at least one integer-valued solution, $n_1, n_2, ..., n_P$ for (1). In general, there may be more than one solution to (1).

We note that the model described in (1) has the following two shortcomings: Firstly, (1) does not use the observations $(y_1, y_2, \ldots, y_L)$, which could aid in determining more accurate estimates for the exogenous intensity. Secondly, (1) does not take into consideration the probablistic nature of the blocking on links; it may result in a solution wherein a link has vastly differing blocking probabilities for different OD pairs.

2.1 Using Link Blocking Probabilities

The shortcoming of the model formulation in (1) for estimating the exogenous intensity is that it does not take into account the probabilistic nature of the blocking occurring on each link: it does not differentiate between solutions with differing proportions of blocked calls in a link for the calls corresponding to the different OD pairs that pass through that link. We assume that the calls offered to each route corresponding to an OD pair form a Poisson process and thus every call which arrives on a link sees the same distribution of states on that link. Consequently, the blocking probability of a link would be the same for all OD pairs using the link. Therefore, we favor solutions that maintain a proportion of blocked calls for each OD pair in accordance with the blocking probabilities of the links that the calls of this OD pair are routed through.

In matrix form (Refer to the detailed math in the Appendix.), we can write

$$A = tHX + \Delta \tag{2}$$

where

$$\begin{aligned} A &= (a_1, a_2, a_3, ..., a_L)^T, \\ X &= (x_1, x_2, x_3, ..., x_P)^T, \\ \Delta &= (\delta_1, \delta_2, \delta_3, ..., \delta_L)^T. \end{aligned}$$

In (2) , A and H are the random quantities whose values we observe, X is the unknown vector we want to estimate, and Δ is the error with $E_X(\Delta) = 0$ for any given X. (Refer to the Appendix for the detailed math.)

We can now state the problem of estimating exogenous intensity as follows: With the process of offered calls to links evolving according to the model developed in (2), given the observation of a_k, $k = 1, 2, ..., L$, determine the estimator of the exogenous Poisson traffic intensity X such that the resulting estimator optimizes a certain criterion. The model in (2) represents a general linear model for the actual offered calls to a link as a function of the mean offered exogenous calls. The development of such a general linear model allows us to borrow from the considerable work available on estimation for such models [8] [9] [11] and, in what follows, we calculate the parameters for such a model.

2.2 Least Squares Estimation

The least-squares estimator [8] [11], $\hat{X}_{ls}$, yields the estimated value of X with the minimum squared distance to the observations. Thus, $\hat{X}_{ls}$ may be defined by

$$\hat{X}_{ls} = \text{Arg}\ \min_X (tHX - A)^T (tHX - A).$$

The least squares estimation corresponds to determining the $P = N(N-1)/2$ unknowns constituting X such that tHX has the minimum squared distance to the L data points of A. We note here that for any network without full connectivity, L is strictly less than P. Hence, there may exist many $\hat{X}_{ls}$'s satisfying $(tH\hat{X}_{ls} - A)^T (tH\hat{X}_{ls} - A) = 0$.

Given any $\hat{X}_{ls}$, the addition of a vector in N_H, the null space of H, would yield an equally valid $\hat{X}_{ls}$ if the resulting $\hat{X}_{ls}$ is nonnegative. We note that N_H corresponds to a linear subspace of dimension $P - L$.

To deal with the non-uniqueness, a method suggested in [10] computes $\hat{X}_{ls}$ as $\frac{1}{t} H^{-R} A$ where H^{-R} is the right inverse of H such that $HH^{-R} = I$. Hence,

$$\hat{X}_{ls} = \frac{1}{t} H^{-R} A = \frac{1}{t} H^T (HH^T)^{-1} A.$$

This solution corresponds to the minimum energy condition (i.e., the one that minimizes $\hat{X}_{ls}^T \hat{X}_{ls}$) [1] which spreads the magnitude of $\hat{X}_{ls}$ as evenly as possible. Note that this approach may however violate the condition that $\hat{X}_{ls} \geq 0$.

3 ECP clustering and Signaling Traffic

In addition to the voice traffic carried by the network, a second signaling network is used for call setup, maintenance, hand off, and termination. During each phase of the call, messages are passed between the network nodes via the IMS ring. This section describes a basic model for analyzing the signaling traffic generated given the topology, routing policy and OD pair traffic. This model allows us to point out possible bottlenecks in the signaling network, and further to recommend changes in the topology and routing policy to alleviate the congestion.

3.1 Modeling Message Traffic

While voice traffic is carried on trunks connecting DCSs, all signaling is routed through ECPs via the IMS ring. Figure 2 illustrates connectivity of cell sites, DCSs and ECPs. For every call from a MS, the cell site containing that MS signals the ECP directly that a call is being generated. The ECP determines the call origin and desired destination and the DCSs involved in routing the voice call. For each DCS involved, voice trunks are allocated appropriately. If the call spans multiple cell sites governed by multiple ECPs, the signaling traffic is carried on data links between the ECPs.

As an example, consider a call from a MS in cell site 1 (CS1) to a MS in cell site 2. ECP-1 will communicate with CS1 and determine that the call destination (CS-2) is within ECP-2. ECP-1 and ECP-2 generate the routing path for the call, and the DCSs involved are signaled: ECP-1 signals DCS-A and DCS-B, ECP-2 signals DSC-C and DCS-D. ECP-2 additionally signals CS-2 that it will be receiving the call.

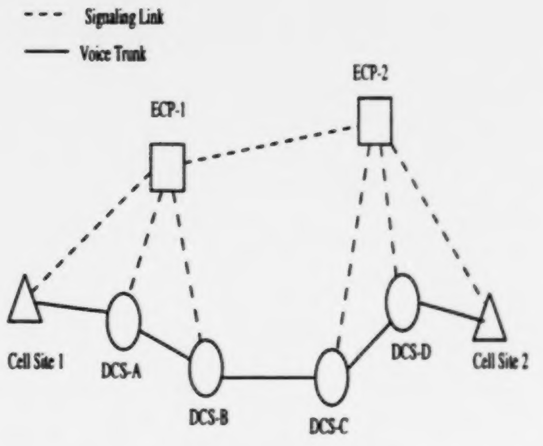
Signaling Link
Voice Trunk
ECP-1
ECP-2
Cell Site 1
DCS-A
DCS-B
DCS-C
DCS-D
Cell Site 2

Figure 2: ECP Clustering

The actual voice channel path is CS-1, DCS-A, DCS-B, DCS-C, DCS-D, and CS-2. The above example illustrates the worst case scenario in terms of signaling traffic generated: inter ECP mobile-to-mobile calls. Other call types include mobile-to-land, land-to-mobile, mobile-to-gateway, and gateway-to-mobile. Calls involving land are routed to/from a PSTN. For purposes of simplification, the switching stations involved in routing a call are broken down into three types: origination node, intermediate node(s), destination node. In the sense that a node is used for switching the actual voice traffic, a node may be either a DCS, a PSTN, or the GATEWAY. In the above example, DCS-A is the origination node, DCS-B and DCS-C intermediate nodes, and DCS-D the destination node. DCS nodes are the most common since at least one DCS will be involved for any call type. Only DCS nodes can be intermediate nodes, and then only for mobile-to-mobile call types involving more than three DCSs. PSTN nodes may be either the source or destination of call. Since all DCSs are fully connected with all PSTNs, calls of this type do not utilize any intermediate nodes for routing. The GATEWAY node is considered in the same fashion as the PSTN. It may be either the source or destination of a call. The GATEWAY is also fully connected with all DCSs, thus no intermediate nodes are used for switching. The IMS ring is responsible for communication between the different nodes connected to the ECP. The ECP Complex contains the interconnection between cell sites, DCS nodes, and the ECP. Cell sites access the ring through Cell Site Nodes (CSN), and DCSs through Digital Switch Nodes (DSNs). CDN and ACDN connections are used for establishing, routing, maintaining, and terminating the call.

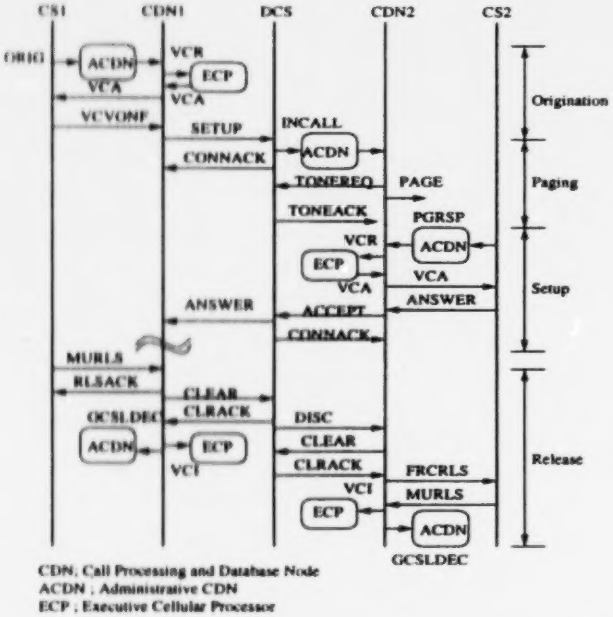
CS1
CDN1
DCS
CDN2
CS2
ORIG
ACDN
VCR
ECP
VCA
VCA
VCVONF
SETUP
INCALL
ACDN
CONNACK
TONEREQ
PAGE
TONEACK
PGRSP
VCR
ACDN
ECP
VCA
VCA
ANSWER
ANSWER
ACCEPT
CONNACK
MURLS
RLSACK
CLEAR
GCSLDEC
CLRACK
DISC
ACDN
ECP
CLEAR
VCI
CLRACK
FRCRLS
VCI
MURLS
ECP
ACDN
GCSLDEC
Origination
Paging
Setup
Release
CDN; Call Processing and Database Node
ACDN ; Administrative CDN
ECP ; Executive Cellular Processor

Figure 3: Intra-DCS Mobile-to-Mobile Call

The signaling traffic generated is expressed in terms of messages generated for all IMS Rings of all ECPs involved in routing the call. This measure is rather simple but effective in describing the quantity of signaling traffic load as in [7]. Given the classification of nodes as origination, intermediate, or destination, it is possible to determine the number of messages generated for each node type independent of call type. Messages generated by a call involving a particular node actually refer to the ECP associated with that node. Thus, the origination node generates messages for the ECP governing the cell site associated with the mobile unit making the call. Figure 3 illustrates the details of an intra DCS mobile-to-mobile call. Each arrow represents the generation of a single message. In determining IMS ring signaling traffic, only those messages generated that must travel on the ring are of interest. As seen in Figure 3, this corresponds to messages generated between CS, ACDN, CDN, ECP, and DCS connections on the ring.

For intermediate nodes (DCSs involved in intermediate routing), the number of messages can be approximated by examining the messaging traffic generated for assigning a voice channel for the either the origination or destination node. Referring to various call flow diagrams, 5 messages are involved in establishing the voice channel at the DCS level: (7, 10, 21, 25, 26) for origination node, (20, 22, 29, 30, 31) for the destination node. This strongly suggests that any in-

Table 1: Total Message Counts

Orig. Node:	15 messages for associated ECP
Interm. Node:	10 messages
Dest. Node:	20 messages

termediate nodes would generate 5 messages to establish the voice channel switching for the intermediate DCS. In addition to this, however, these same messages must be propagated to/from the next/previous nodes, bringing the total message count for intermediate nodes to 10. (Note this analysis is only an approximation based on the data provided. Nonetheless, the results will still be useful in indicating sources of congestion.) Table 1 summarizes this message count.

Note the ECP associated with nodes along the path of the call need not be different. For example, a call originating and destining within the same DCS would generate 15+20 messages for the associated ECP. For a call originating and destining within the same ECP but different DCSs would however generate 15+5+20 messages if a single additional intermediate DCS was needed for routing (the intermediate DCS, in this case, is also associated with the same ECP).

3.2 Routing Policy and Estimated Traffic

For a given routing policy and estimation of OD pair traffic, the IMS signaling traffic generated by that traffic can be determined. The total number of messages at an ECP is simply the total number of messages generated by all of its DCSs for any classification of the DCSs. In other words, all OD pairs that use a DCS within that ECP generate messages for the ECP. The method used for calculating this is outlined below:

```
For each OD pair (orig,dest) do
  For each route (orig, inter[1], inter[2]..., dest) do
    Let t = estimated traffic for OD pair (orig,dest)
    Let p = probability that this route is used
    Add 15*t*p to ECP associated with orig
    Add 20*t*p to ECP associated with dest
    For each intermediate node (inter[1], inter[2]...)
      Add 5*t*p to ECP associated with inter[i]
    EndFor
  EndFor
EndFor
```

The probability that a route is used is determined by the blocking probabilities. Assuming that there are three routes with blocking probabilities B1, B2, and B3, the probabilities assigned for each route (p1, p2, and p3) can be assigned as follows:

$$p1 = (1-B1), p2 = B1\cdot(1-B2), p3 = B1\cdot B2\cdot(1-B3) \tag{3}$$

Note that this analysis assumes that all messages are of the same size. In general, this will not be the case.

4 Simulation

Once the exogenous traffic is known, we can check the network performance using the simulation tool while changing various control parameters such as routing policies, cell clustering, and DCS clustering. The discrete event simulation program is written in C for this purpose. The exogenous OD pair traffic estimated becomes the input of our simulation, where all the parameters are simulated and the measurements data for each network element are then collected. Hence the effect of changing any control parameters are easily verified in real time.

5 Numerical Analysis

We have observed in our numerical study that all the traffic estimation methods are valid in many realistically sized networks. Amongst the methods in [6], the LSE method exhibited the efficacy when applied to the KMT Autoplex 1000 network. We have repeated the traffic calculation with many other routing patterns assuming the shortest path first approach, and we observed some variations in the results. However, as an illustration, we present the results of one specific study with the topology given in Figure 4.

5.1 Traffic Estimation

The trunk measurement data from the *PACE* system consider the DCS as the origin and/or destination node. From the peg counts, the overflow counts, and the usage, it is possible to calculate various DCS-to-DCS pair traffic under the assumed routing pattern. The LSE method requires solving constrained quadratic optimization to guarantee the existence of nonnegative X, but we used the minimum energy condition for simplicity. In order to find the right inverse of H, the Gaussian elimination with scaled partial pivoting method[4] was used. From our results, we can

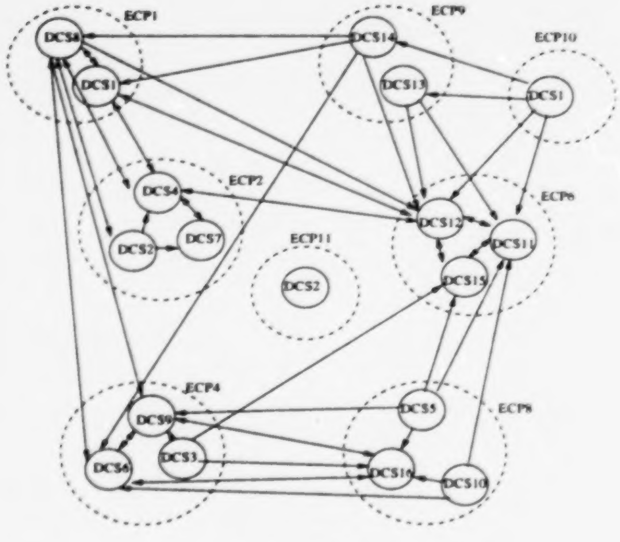

Figure 4: Network Topology of KMT

make some very notable observations. One such a observation is that the traffic flow is largely from the wireless DCSs to the PSTN switches. This is a clear indication that reaching the mobile units was much more difficult from the land subcribers. What may make this asymmetry worse is the pattern of trunk capacity which also coincides with this asymmetric pattern.

We also noted that there is a very significant design problem with DCS 2 in ECP 11. DCS 2 has no direct connections to any of the other DCSs in the network. We see however there is very large amount of traffic flowing from and to this DCS. This indicates that this large amount of traffic travels the network using multiple links which is clearly inefficient use of the network capacity.

5.2 Signaling Traffic

A series of numerical studies were performed using the raw data provided for the eight ECPs in the KMT network: 1, 2, 4, 6, 8, 9, 10, and 11. Fixed alternate routing is used, choosing the direct path first (if it exists), then choosing longer paths as necessary. If more than one path exists of the same length, the order in which they are chosen is determined randomly at the beginning of a given run, but fixed for that run. Figures 5 shows the number of messages generated as a function of ECP using this routing policy, whereas in Figure 6 only more than one hop paths are assumed to be available with the fixed alternate routing policy.

The message count is also broken down by mes-

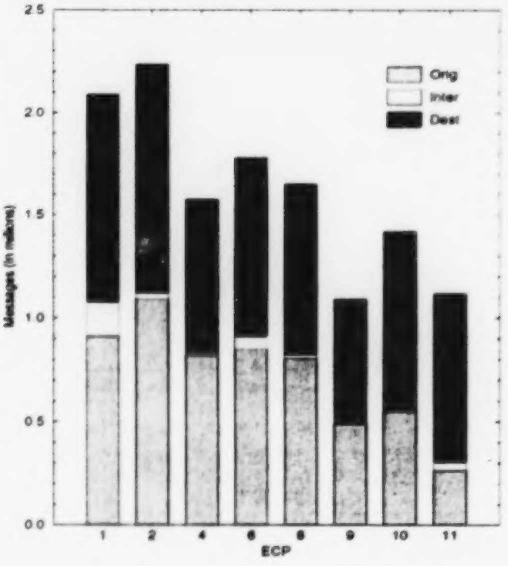

Figure 5: ECP Message Count: Routing Pattern 1

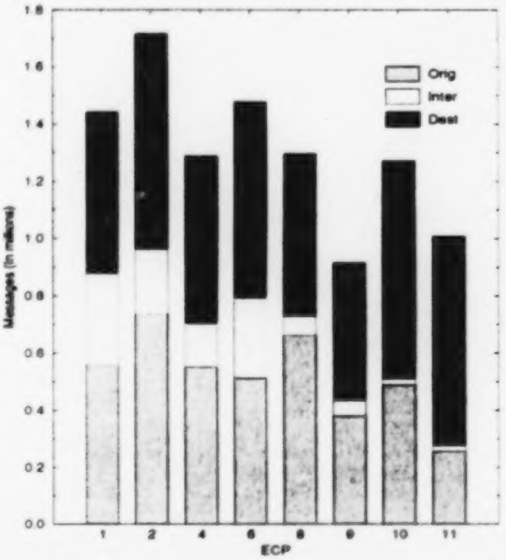

Figure 6: ECP Message Count: Routing Pattern 2

Table 2: Effects of Call Mix

Ratio (orig/dest)	Upper Bound(UB) (in millions of messages)
30/70	1.998
40/60	1.944
50/50	1.890
60/40	1.836
70/30	1.782

sage type: origination, intermediate, or destination. With the exception of ECP 1 and ECP 2, virtually all the messages generated were due to either originating or destining calls. For ECP 1, as much as 12% of the messages generated are due to calls using intermediate DCSs within that ECP. For ECP 2, it is at most 6%. This in effect reduces the number of originating and destining calls for nodes within these two ECPs. More importantly, the total number of messages generated for all ECPs is not evenly distributed. On average, ECP 2 generates twice as many messages as ECP 9. This is not entirely surprising given that ECP 2 governs three DCSs and ECP 9 only two. Still, the number of messages generated per DCS for ECP 2 is still 1.4 times greater than that for ECP 9. The specifications for the equipment used indicates that a single ECP is capable of handling 108000 Busy Call Hour Attempts (BCHA). Assuming that a call attempt may be either a call originating or destining within that ECP, than this sets an approximate upper bound on amount of messages capable of being handled by a single ECP. For example, assuming 50% of the calls are originating, and 50% destinating, this implies an upper bound of 1.89 million messages. Table 2 shows the effect of different ratios.

The total utilization factor for each ECP is then obtained as in Table 3. As the Table 3 indicates, ECP 2 is exceeding its capacity for all five ratios used, while ECP 9 and ECP 11 are up to 60% of their capacity. The most significant indication from this analysis is that the distribution of the load between ECPs is not equal. By moving some of the DCSs of highly utilized ECPs to underutilized ECPs, the possibility of signaling network congestion can be greatly reduced. As one would expect the number of intermediate messages generated increases. For ECP 1, 23% of the messages are due to intermediate nodes, as opposed to 12% for the previous study. This underscores the importance of a good routing policy that minimizes path length.

6 Conclusions

Some of the observations we can make about the KMT network through our management system are:

- Many of the ECP clusters are not connected bidirectionally. This could result in routing patterns that may end up consuming a large number of links.
- Some of the ECP clusters are not well connected at all. This could result in low survivability of those ECP clusters.
- The interconnectivities within a single ECP complex seems low. This is most notable for ECPs 8 and 9 as can be observed in Figure 4. This also makes the utilization of short routing paths difficult.
- The connectivity to the PSTN switches in terms of capacity is much better than the connectivity from the PSTN switches. More balanced capacity distributions may be desired.

While proper operation of a network requires that the intensity of exogenous traffic be known accurately, currently there exists no mechanism to measure such information for the entire network in real-time. One of the main tasks in this study was to determine the point-to-point OD pair traffic intensity from the available trunk and cellular measurements. With the network traffic determined through these methods, Korea Mobile Telecom is able to monitor real time network performance such as end-to-end call blocking and utilization of all network equipment and facility including the signaling network components.

A Appendix

With the model assumptions we have made, it is known that the blocking probabilities can be evaluated by an extension of the classical Erlang fixed point equations [2] as follows: Let B be the vector containing the blocking probability of each link. Define the vector b where the element b_k is either 1 (if link k is in a blocking state) or 0 (if not). Hence, $b \in \{0,1\}^L$. Define,

$$\begin{aligned} p(b, B) &= \prod_{k=1}^{L} {B_k}^{b_k}(1 - B_k)^{1-b_k}, \\ v_k(b) &= \sum_{i \in W_k(1)} tx_i + \sum_{m=2}^{M} \sum_{i \in W_k(m)} (\prod_{h=1}^{m-1} (1 - \\ &\quad (1 - b_{ih1})(1 - b_{ih2})))tx_i, \end{aligned}$$

Table 3: Total ECP Usage

ECP	Total messages	30/70	40/60	50/50	60/40	70/30
1	1.978	0.990	1.017	1.047	1.077	1.110
2	2.266	1.134	1.165	1.199	1.234	1.272
4	1.756	0.899	0.903	0.929	0.956	0.985
6	1.852	0.927	0.953	0.980	1.009	1.039
8	1.630	0.816	0.838	0.862	0.888	0.915
9	1.094	0.547	0.563	0.579	0.596	0.614
10	1.290	0.646	0.664	0.683	0.703	0.724
11	1.082	0.542	0.557	0.572	0.589	0.607

for $k = 1, 2, .., L$ and the measurement interval t. Then B is a solution to the system of equations,

$$B_k = E\left(\sum_b p(b, B)v_k(b), s_k\right) \quad k = 1, 2, ...L, \quad (4)$$

where $E(\cdot\ ,\ \cdot)$ is the Erlang-B function.

We note that B is a function of the exogenous traffic intensity X, where $X = (x_1,\ x_2,\ x_3,\ ....,\ x_P)^T$.

Now, assuming that $i \in W_k(m)$ for some m, we note the fractional contribution to the measurement a_k originating from Poisson stream i equals $\prod_{t=1}^{m-1} \tilde{B}_{it}$ where the null product is defined as unity. Let $H = [h_{ki}]_{ki} \in R^{L \times P}$ denote the matrix which expresses the relationship between the mean of the exogenous traffic and the mean of the traffic offered to each link. Then, each element h_{ki} represents the relationship between the measured traffic on link k and the exogenous Poisson traffic between node pair i during a measurement interval and so,

$$h_{ki} = \begin{cases} \prod_{t=1}^{m-1} \tilde{B}_{it} & \text{if } i \in W_k(m) \text{ for some } m \\ 0 & \text{otherwise.} \end{cases} \quad (5)$$

Then the observation a_k during a measurement interval is the realization of a Poisson random variable with mean $t(HX)_k$ where $(HX)_k$ is the k^{th} element of the column vector HX. Thus, we may write a_k as $t(HX)_k + \delta_k$, where δ_k is a random variable such that $t(HX)_k + \delta_k$ is a Poisson random variable with mean $t(HX)_k$.

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Telecommunications Developments in the Years Ahead

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1. Abstract

This paper gives a broad overview of the Hong Kong telecommunications industry. Hong Kong has a vibrant and world-class industry and the policy intention is to keep it that way. The paper outlines the successes to-date and what the Hong Kong Government has done to provide the right environment to generate opportunities for the private sector to invest in, and develop, our telecommunications industry. For those who may wish to research some of these issues in depth, you will find that we operate an open and transparent regulatory regime in Hong Kong. Information is readily available and our Internet Home Page at http://www.ofta.gov.hk is one convenient source of information.

The Role of Government in Hong Kong with respect to telecoms

The Hong Kong Government has two responsibilities with respect to the telecommunications industry in Hong Kong:

- setting the policies;
- regulating and administering the industry in accordance with the established policies.

To discharge the first responsibility, the Government has set three policy objectives to guide the development of the industry. These are -

- that the widest range of quality telecommunications services should be available to the community at reasonable cost;
- that telecommunications services should be provided in the most economically efficient manner possible; and
- that Hong Kong should serve as the pre-eminent communications hub for the region now and into the next century.

It should be noticed that we have not listed the introduction of competition as a direct policy objective but it has been our experience that competition is a very effective mechanism for achieving our second policy objective i.e. increased economic efficiency. Generally in Hong Kong we foster and encourage competition where possible and this is also the case in the telecommunications industry.

The second responsibility of the Hong Kong Government (to regulate and administer the industry) is being met through the statutory position of the Telecommunications Authority (TA) and the TA's specialist supporting department the Office of the Telecommunications Authority (OFTA). I will say more about the role played by the TA later in this paper.

Most importantly, I must mention that the HKG has no role in operating telecommunications businesses or providing telecoms services to the public. The HKG has no equity or ownership of any telecommunications businesses. Therefore the HKG is truly at arm's length from these businesses and can play the role of an impartial and neutral referee. Furthermore, Hong Kong has no foreign ownership restrictions so this means that a telecommunications company in Hong Kong can be 100% foreign owned.

Structure of Hong Kong Government

Under Hong Kong's laws the Governor-in-Council is the highest policy making body in Hong Kong. Telecommunications policies can be set, amended or varied at this level. However in practice, responsibilities on financial and economic affairs are devolved to the Financial Secretary who in turn devolves telecommunications issues to the Secretary for Economic Services (SES). The practical effect is that SES is the policy secretary with the most direct day-to-day responsibility for telecommunications issues in Hong Kong. OFTA is one of the many government departments falling under the SES's administration.

Under the Telecommunications Ordinance, the Governor appoints a person as the Telecommunications Authority (TA) to administer the Ordinance and, otherwise, regulate the industry. The TA is concurrently appointed as Director-General of Telecommunications and heads OFTA. Therefore for the purposes of administering the law, the TA can be considered to be 'independent'. Certainly the TA is independent of the industry operators. He is specifically charged by the legislation to perform many tasks and he is empowered to do so without recourse to other authorities, for example, the Courts. Despite this independence, TA and his department (OFTA) are still part of the machinery of Government. OFTA's staff are civil servants but OFTA is self-financing and operates on efficient business principles and pays a dividend annually to the Treasury.

Hong Kong's Laws

The legal structure covering Hong Kong's telecommunications industry has three levels:

- the Telecommunications Ordinance
- regulations
- licences

The principal law is the Telecommunications Ordinance. It is kept updated as the industry develops and the need for regulation changes. A key feature of the legislation is that it gives very wide discretions to the TA. A full listing of the TA's functions is as follows:

(a) ensure the safety and quality of telecommunications services;
(b) ensure the economic and technical regulation of the Hong Kong telecommunications industry;
(c) ensure the interconnection of telecommunications networks and the shared use of facilities where the Authority thinks appropriate;
(d) control and administer the Hong Kong numbering plan;
(e) promote economic efficiency in the provision of telecommunications networks, systems, installations, customer equipment and services;
(f) promote competition in the provision of telecommunications networks, systems, installations, customer equipment and services;
(g) protect consumers' interests;
(h) regulate and manage the use of the radio frequency spectrum;
(i) prevent harmful interference;
(j) issue licences as provided for under the Ordinance;
(k) administer licences as provided for under the Ordinance and the licence conditions;
(l) carry out his functions in accordance with directions of the Secretary for Economic Services on matters of general policy;
(m) represent Hong Kong, as appropriate, at international technical and regulatory forums;
(n) require accounting practices and implement tariff monitoring and price control in accordance with the Ordinance;
(o) investigate, and take appropriate action for, breaches of the Ordinance or licences;
(p) administer conventions relating to telecommunications, as applied to Hong Kong;
(q) advise the Secretary for Economic Services on matters relating to the telecommunications industry in Hong Kong;
(r) advise the Secretary for Broadcasting, Culture and Sports and the Broadcasting Authority on matters relating to the technical aspects of broadcasting;
(s) report to the Secretary for Economic Services and the Legislative Council on his activities and the state of the telecommunications industry in Hong Kong.

Regulations are used quite commonly in Hong Kong to support day to day administration of the industry. For instance there are regulations for exempting certain equipment from licensing, for price

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control purposes, for radio frequency interference limitations etc. etc.

Licence conditions are also framed for the needs of specific sectors of the industry. Licensees are required to comply with the terms of their licences which are now generally public documents.

The Hong Kong Telecommunications Industry

The telecommunications industry in Hong Kong is very advanced when measured across many factors. There are many operators competing in the market: they make available a wide range of advanced services and the use of services by consumers is very high.

The mobile sector is a particularly vibrant sector of the industry. This is because the mobile sector has always experienced competition, for example, paging has never been monopolised and the cellular telephone services have been competitive since 1984. Some statistics will show how dynamic this sector really is.

For paging, there are 31 licences which use 68 radio frequency channels. The number of active customers total 1.05 million. That represents a population penetration of 17% which is quite high on a world-wide comparison.

For cellular telephone, there are 5 digital licences held by four companies. Three of these use GSM technology, one uses US-IS54 TDMA and the other uses US-IS95 CDMA. As at October 1996 there were 1.12 million cellular customers, that is 18% penetration rate which is again very healthy. The number of cellular customers grew by around 80% in the last 12 months and is expected to grow by at least another million customers in the next 2 to 3 years and grow further beyond that. To meet this extra demand, six Personal Communications Licences (PCS) have been issued - as two of these licencees have been won by existing operators the total number of cellular/PCS operators will be 8 and they will hold 11 cellular/PCS licences among them. I should note for completeness that the four analogue cellular networks are now not being used very much. 98% of all cellular handsets in Hong Kong are now digital (i.e. only 2% analogue). The few remaining analogue sets are mainly used for roaming service to China but this will phase down further as automatic roaming on digital becomes established (for example, GSM automatic roaming to China commenced in August 1996).

In the fixed services sector, competition has been progressively introduced. In the value added services sector, (or what we call PNETS - Public Non-Exclusive Telecommunications Services sector), there are 183 licences. Of these 92 provide Internet Services and 18 provide international Call-Back services. Under the law in Hong Kong, a licence is only required if physical infrastructure is installed in Hong Kong. Therefore the market is open for the provision of certain services in Hong Kong (for example, off-shore based calling card services), without a licence and this in fact is quite common in addition to the number of licensed services listed earlier.

For local fixed telecommunications services, competition was introduced last year when the Hong Kong Telephone Company's (HKTC) monopoly expired on 30 June 1995. The HKTC was issued a new licence as were 3 new competitors - therefore we now have four operators providing local fixed telecommunications network services (FTNS) in Hong Kong. Each of the new entrants is building their own network and competition is producing new services and keener prices. I will say more on the issues involved in fixed network competition shortly.

The international services sector is the only sector still retaining some elements of monopoly. Here Hong Kong Telecom International (HKTI) has a 25 year exclusive licence issued in 1981 (i.e. it is due to expire in 2006) over certain circuits and services external to Hong Kong. However this licence has not totally precluded competition: in fact, there is a liberal regime in value added services including managed data network services (MDNS), call-back services and voice value added services. Shortly international simple resale of facsimile and data will be allowed as will virtual private network (VPN) services. Furthermore, companies and organisations may install their own circuits (e.g. by VSAT) for carriage of their own international traffic - so far 26 licences for these purposes have been issued. The Hong Kong Government is currently holding a dialogue with HKTI to review the international telecommunications arrangements - in particular to study whether the HKTI licence as it presently stands is best in terms of our objective of maintaining Hong Kong's status as the pre-eminent hub in this Region.

Major Regulatory Issues in Hong Kong

Hong Kong has implemented a competitive safeguards regime which is in step with contemporary regulatory thinking in developed economies. In this regard I should mention five particular measures:

- the establishment of OFTA. An effective regulator adequately empowered to gain information, analyse it and make and enforce decisions, can act to assist generally in resolving impasses, for example, in interconnection between unequal commercial rivals and can determine these matters if agreements cannot be reached. The TA has issued many interconnection guidance notes (these are publicly available) and sound interconnection arrangements have been established among the operators;
- the introduction of fair trading rules and prohibitions on the dominant carrier from abusing its market power. These measures are aimed at ensuring competition remains fair;
- the introduction of price controls to limit the dominant carrier's ability to cross-subsidise between market sectors, particularly from those sectors not facing immediate competition to those that are, and to otherwise limit practices such as predation and bundled or tied service offerings;
- improving the transparency of a dominant carrier's operations through structural and/or financial separations; and
- ensuring equity in numbering allocations and national number planning by putting strategic control with the regulator.

What I should like to do is to take three issues that flow from this competitive safeguards regime to illustrate how we are tackling them in Hong Kong. The three issues I will focus on are interconnection, customer access and number portability.

Some Examples of Key Issues in Hong Kong

Interconnection It is an obvious truism that in a network based industry, interconnection is a vital pre-requisite for effective competition. Hong Kong's policy recognises this fact and in the period March 1995 through June 1995 I issued no less than 10 TA Statements on interconnection matters. These Statements cover many interconnection issues which include the technical configurations as well as the cost basis for interconnection which has been established as Long Run Average Incremental Costs (LRAIC). We have categorized interconnection into two broad classes. Type I interconnection (diagram 1) is the standard form of interconnection between network gateways. This is a relatively well established mode of interconnection and not worth dwelling on for today's purposes.

Type I - Interconnection between Network Gateways

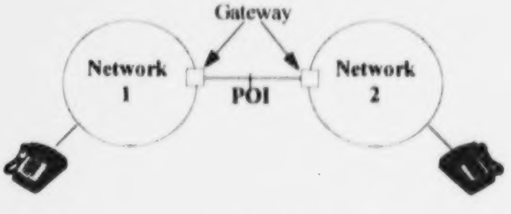


DIAGRAM 1

Type II interconnection (diagram 2) is, however, a different approach which recognises the difficulties inherent in establishing competition within the vertical local loop environment of Hong Kong. This form of interconnection is aimed at allowing interconnection at the local loop level.

Type II - Interconnection at Points in the Local Loop

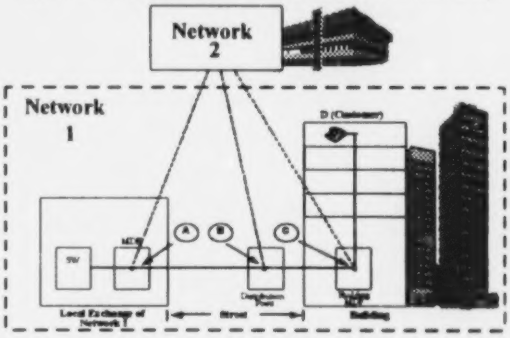


DIAGRAM 2

Main characteristics of Type II interconnection are:

- Interconnection of Network 2 to Network 1 is possible at any of the points A, B and C.
- Interconnection in this configuration is only permissible upon the request of the customer at point D to become a direct customer of Network 2.
- After interconnection, the customer at point D becomes a direct access customer of Network 2.
- After interconnection, the operator of Network 1 continues to own, maintain and support the local loop.

Two of the three new entrants have already signed commercial agreements with HKTC for Type II interconnection and they will be offering services over this form of interconnection in the next few weeks. The remaining new entrants will also avail itself of Type II interconnection in the near future.

Customer Access. For the sake of simplicity, customer access arrangements can be sub-divided into two class - direct and indirect. The first tends to concern the acquisition of physical access facilities to the customer; the second tends to concern the provision of competing services to customers irrespective of the supplier of the physical access facilities. In Hong Kong we allow both types. Direct access may be achieved by an operator building its own facilities, for example, installing a wired local loop or utilizing wireless local loop technologies. An operator may also decided to lease direct access facilities from another operator or utilize type II interconnection where available.

However, indirect access in the Hong Kong environment is somewhat more interesting. Diagram 3 shows the IDD access arrangements in Hong Kong.

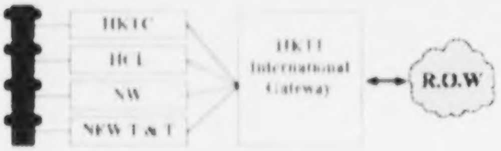


DIAGRAM 3

The entire Territory of Hong Kong constitutes one local zone. Therefore all long distance and international direct dial voice telephone services pass through the monopoly service of Hong Kong Telecommunication International (HKTI). All four local telephone companies connect to HKTI on a non-discriminatory basis and are paid delivery fees for originating and terminating calls to and from the international gateway. The default code for outgoing IDD access is 001. Therefore, irrespective of the line provider, a consumer dialing 001 will obtain IDD service through the operator that provides the exchange line. However each of the four local operators has been issued a 00X code (where X is 6 to 9 inclusive). Therefore a consumer can gain the services of any of the four telephone companies by simply dialing 00X in lieu of 001. This approach does not inconvenience the customer by imposing extra digits to dial, it is a simple system, improves choice and can be said to be a true form of "equal access".

Portable Numbering. The last illustration I wish to raise is number portability. Our studies indicated that licensing more operators and providing a sound interconnection environment were unlikely to be sufficient to make the competitive choice attractive to consumers. Our surveying indicated that 68% of customers would not switch operators if they were required to change their telephone numbers - even if they were offered a price reduction of about 15%. The TA therefore decided to mandate operator portability in Hong Kong. In truth this was not a difficult decision to take as operator portability was estimated to result in an NPV for the period 1995 to 2010 of US$200 million. Geographic portability has an even higher NPV (of about US$1,150 million) but the TA decided competitive market forces would ensure geographic portability was offered to consumers and this in fact has proven to be the case.

Operator portability is now being provided among operators using simple 'call-forwarding' techniques. This is only an interim solution - the industry is working towards the implementation of a full intelligent network based solution by the end of 1996. This has raised some interesting issues none of which are proving to be insurmountable in an environment where the three new entrants are introducing intelligent networks in any event and the ex-monopolist is introducing intelligent overlays on its 100% digital switching platform.

Conclusion

Perhaps, these illustrations of practical regulatory issues in Hong Kong form a suitable basis upon which I might draw a final conclusion to my comments. At the beginning of this presentation I said that the Hong Kong Government believes it does have a critical role in establishing the right framework for the development of the telecommunications industry. This role encompasses:

- the setting and articulation of the policy goals; and
- the establishment of comprehensive regulatory arrangements with an adequate regulatory apparatus and sufficient competitive safeguards.

These two steps create the environment. Additionally, the Hong Kong Government believes it has another important role and that is to create opportunities for the private sector to invest and participate in the industry. Having done this, we try to step back and allow the market mechanisms to work. Or in other words, we are content to clear a path and keep out of the way.

I venture to suggest that our record has been very effective and very encouraging. We are rightly proud of our telecommunications industry and we believe it is a tremendous asset upon which we can develop Hong Kong's services industry. As we embark on the Information Age I am confident Hong Kong will maintain its leading position as the pre-eminent telecoms hub in this region. Of course, with the return of Hong Kong to China next year we expect that Hong Kong's telecommunications industry will continue to operate autonomously as provided for under the Basic Law. And Hong Kong's telecommunications industry will continue to play its important role in developing the existing strong economic links between Hong Kong and China (particularly Southern China) and this will in turn continue to support the development of the overall Chinese economy.

Hong Kong Update

Keith Bernard

Abstract

Hong Kong has experienced, and continues to experience, substantial and rapid regulatory change.

Internally, liberalisation of the international and local market have changed the market place for telecommunications services and opportunities for new entrants. The local market in Hong Kong is now fully contestable - ahead of the conditions that exist in the US, the UK, and Australia. The remaining necessary liberalisation is the pricing flexibility for the incumbent so that the full benefit of competition can flow to consumers.

Externally, the FCC indications of enforcing "benchmark" accounting rates to bi-lateral arrangements and the WTO negotiations is a factor of concern to both Hong Kong Telecom and numerous other carriers. A multi-lateral approach to accounting rate reform holds far more promise in achieving the desired result than confrontational action

In the last 18 months, Hong Kong has seen some of the most rapid development of market liberalisation to take place at the telecommunications industry.

This paper will review both the external and internal forces that have generated some changes which are already finalised as well as raising a number of additional issues that have not come to culmination. These forces are the result of technology - as is well known - as well as regulatory change both in Hong Kong and possibly in the United States.

External forces

As this paper is written, it is anticipated that there will be an FCC decision on December 13, 1996 which will address the international accounting rate system. This issue has been highlighted by FCC Chairman Hundt and there has been particular reference to Hong Kong in some of his public statements. Accordingly, I fully anticipate that Hong Kong will feature in the December 13th action which is likely to be a Notice of Proposed Rule Making. (NPRM)

The principle concern stated by the FCC is that Hong Kong has had a dramatic escalation in the ratio of inbound/outbound traffic with the US in the last few years moving from a ratio of roughly balance i.e. 1:1 to the current ratio of over 7:1.

This trend is not unique to Hong Kong. An examination of FCC statistics show numerous routes with rapidly growing imbalances of this sort. It is this factor, we are told, which will result to the FCC determining - via their own calculation - accounting rate "benchmarks" which are to be established between US carriers and their foreign correspondents. It is likely that these benchmarks will be broken out in a matrix type form which also categorizes countries by the level of economic development reflecting the particular needs of lesser developed countries.

The most interesting piece of speculation around the NPRM is that the FCC will actually proscribe maximum rates which the US carriers can pay, these maximums reflecting the US - determined benchmarks.

It is widely accepted that accounting rate system in its present form is not optimal. If the driver for change in this system, however is the growing level of settlement imbalance with the US, it is important that the causes of this imbalance are fully understood.

For the Hong Kong/US route, the data indicate that the conventional wisdom as to the cause of a settlement imbalance i.e. arbitrage of collection rates, is not a valid concern. If one looks at both the levels and trends of the HKTI IDD tariff to the United States (not even considering the very low discounted IDD rates charged by the new entrants) in comparison with AT&T basic IDD tariff or even AT&T True World, (see chart 1) one finds that the Hong Kong rates have consistently been lower than the US rates for the last three years and, significantly, have been moving in the opposite direction. HKT rates have continually been decreasing while - contrary to the conventional wisdom - US rates to Hong Kong have been increasing. This has been at a time when accounting rates have consistently been coming down.

Rather than collection rate arbitrage, to truly understand the growth imbalance of traffic between United States and Hong Kong, one must focus upon regulatory policy and technology. The FCC has continually supported the development of card services promoted by US carriers and the creation of the United States as a callback and refile hub. In the last two years, the FCC has legitimised callback and implicitly supported carrier refile by refusing to act upon complaints filed by AT&T. It is these forces on the Hong Kong/US route - also supported by Hong Kong regulatory policy which requires HKTI to pay a "delivery fee" to callback operators (so that their marginal cost of providing an IDD call by a callback is approximately zero) - that have magnified the imbalance and been principally responsible for the growth to the current 7:1 imbalance.

A last point on the imbalance considerations is that, as is well known, calculation of the settlement imbalance excludes all associated revenues. The money that the US carrier receives for calling card service provided to its customers, the revenue that the US callback operator receives from a foreign service provider which utilises the callback services, and the revenues received by US carriers providing refile hubbing services, although substantial - as these carriers are not providing service in order to lose money- do not show up in the accounts which the FCC utilises for settlement imbalance. Rather, merely the cost of providing these services - but none of the revenue - are accounted to demonstrate that there is a "problem".

Beyond the settlement imbalance, the only other stated concern about accounting rates they set a "floor" on collection rates. This is theoretically possible and there are public policy ramifications of such concerns. However, data provided by the FCC indicate that this is not the case in the US. (see charts 2, 3, 4) For US carriers in the last 4 years, retained revenue per minute (after payment of settlement) has actually increased. This indicates that - as indicated by the trend in collection rates mentioned earlier - US IDD prices are actually increasing in many instances when accounting rates are being reduced or, at a minimum, falling less than accounting rates. (see chart 5) In neither instance, however, can it be argued that accounting rates are actually serving as a floor to US IDD rates.

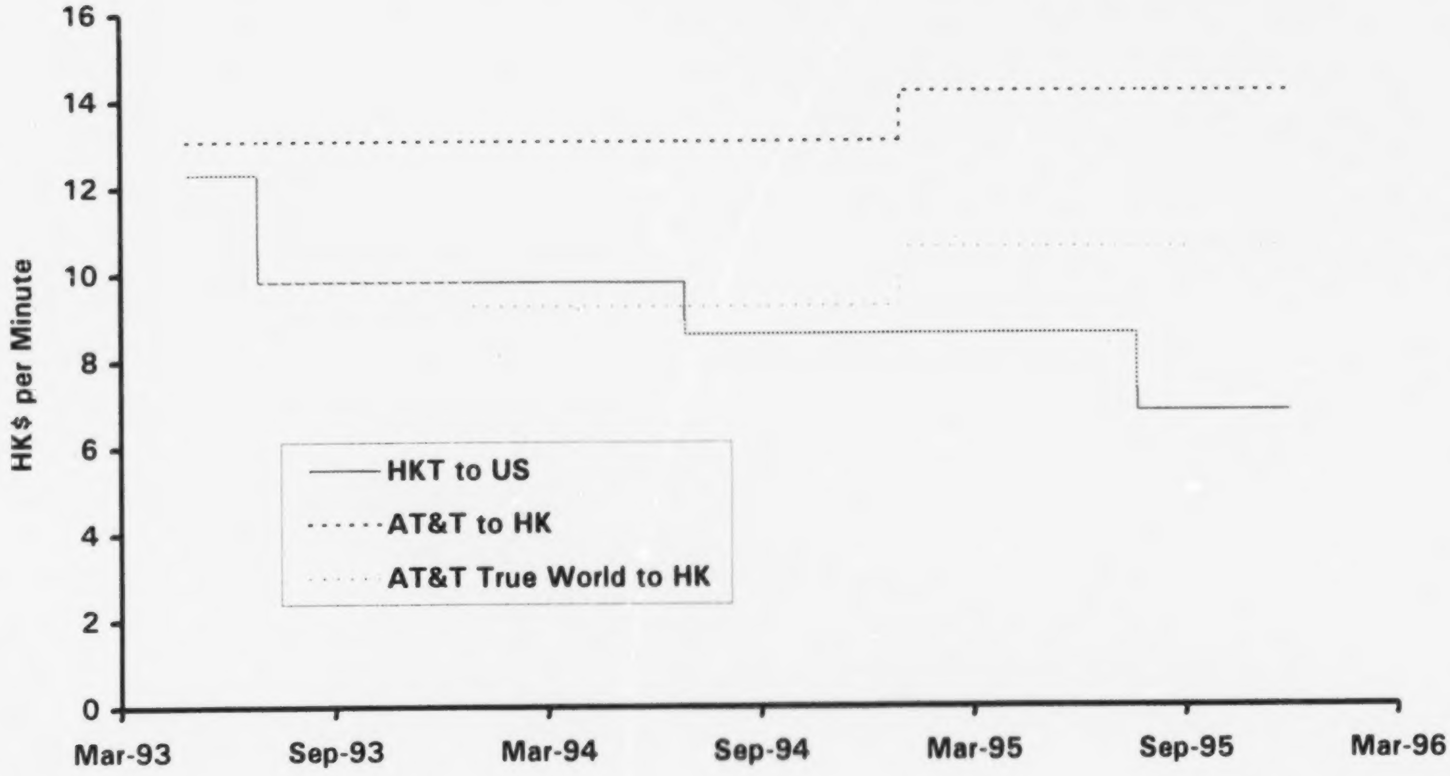
The FCC has taken a two-pronged approach to the use of benchmark rates. In addition to the threat of proscribing rates - which would obviously affect HKTI as well as other Hong Kong carriers as we would no longer be able to pay the delivery fee currently mandated by OFTA - the FCC has proposed that the benchmark rates be utilised in the WTO negotiations.

A proposal by the FCC is quite interesting, but does not and should not pass WTO MFN considerations. As many of you know, the FCC has been utilising a reciprocity test - called the "effective competitive opportunity test" - as a means of limiting market entry by foreign carriers. It is clearly not acceptable in an MFN situation. The recent FCC proposal is that within the WTO, the FCC will grant license to any and all signatories, i.e. MFN compatibility but these licenses will not be "activated" until the licensee accepts the benchmark accounting rates with the United States. This clearly places a new meaning on what it means to have a license i.e. active versus inactive, and additionally, does not meet the WTO standard of no "ex ante" conditions. The mere granting of a piece of paper, i.e. an inactive license, does not make the imposition of benchmark accounting rates somehow "ex post" if that license cannot be utilised until the benchmarks are accepted.

A far better approach to this issue is to utilise a multilateral solution to bring down accounting rates. The Secretary General of the ITU has recently released a paper calling for comments on reform of the accounting rate system to be discussed in Study Group III in May of 1997. Rather than an FCC unilateral type approach, an ITU multi-lateral model can work so that the financial pressures on carriers are mitigated as accounting rates on all routes are simultaneously reduced. The current US approach of unilateral reductions - combined with the fact that US policies have resulted in the US being net outbound to almost all countries - can only serve to generate resistance for such a change as the financial flows to any given US

Chart 1

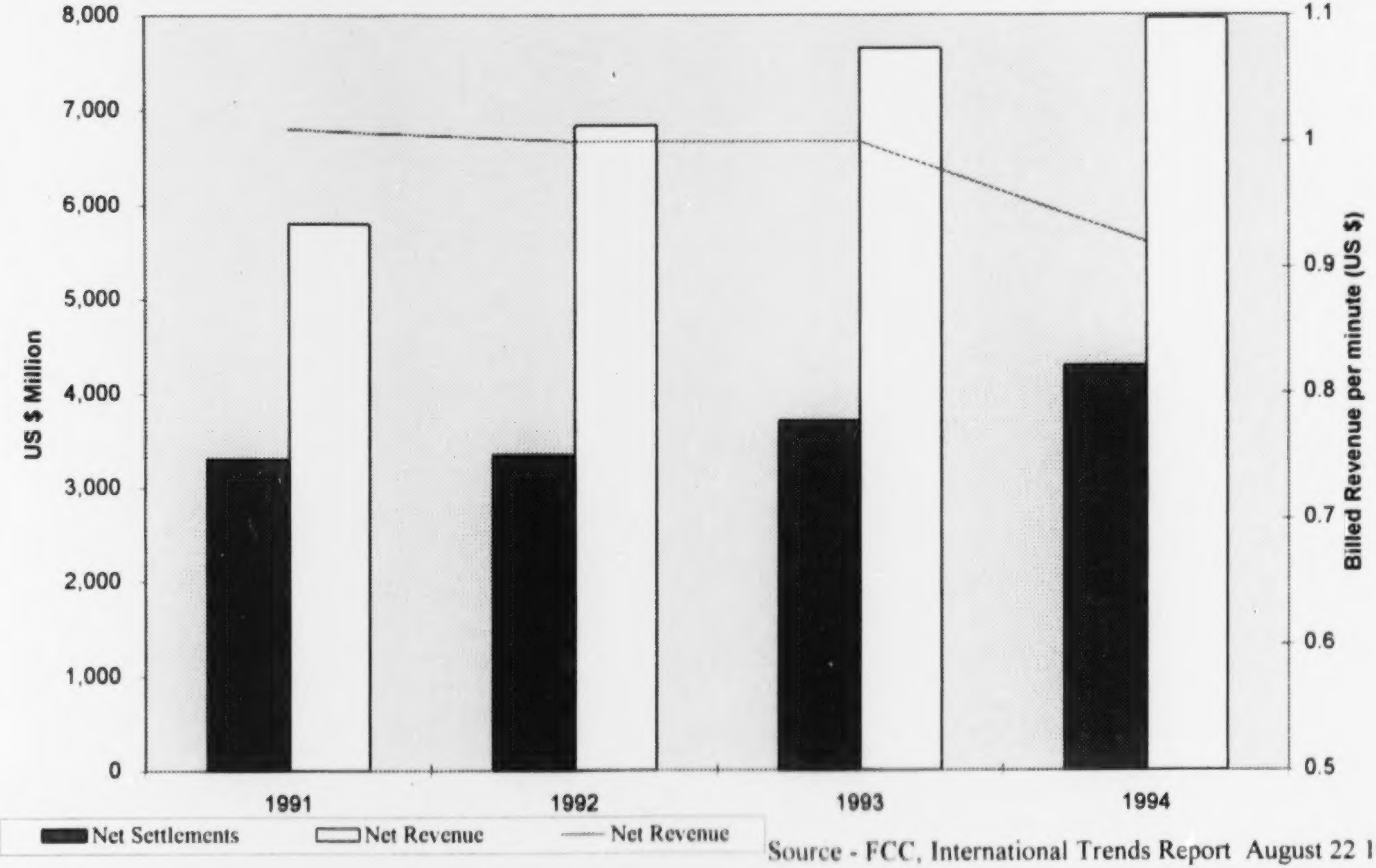
Rates for Trans-Pacific Calls



SPU, 11:30 AM, 12/12/96, T0024D.XLS

International Revenue

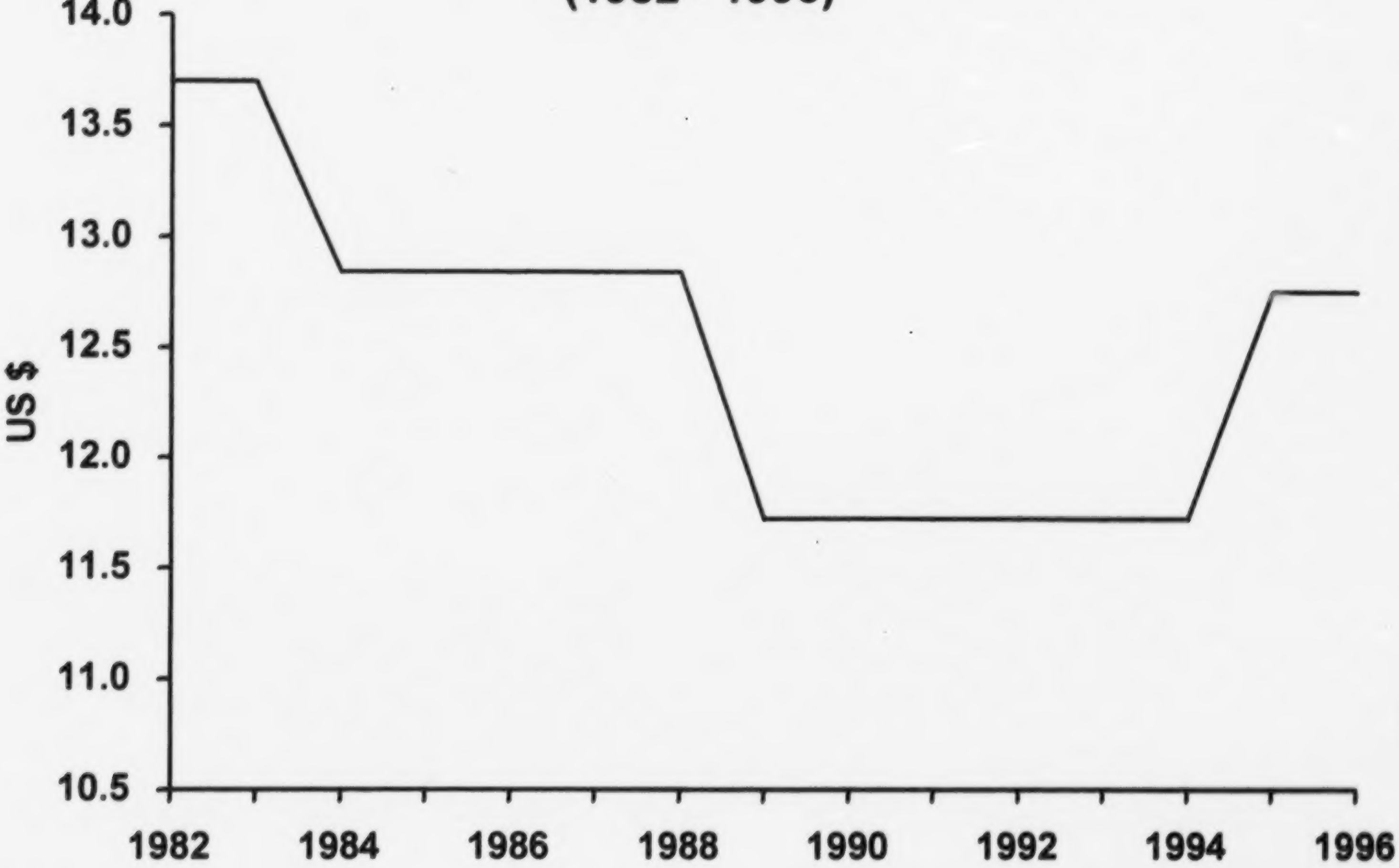
Chart 2



Source - FCC, International Trends Report August 22 1996

Chart 3

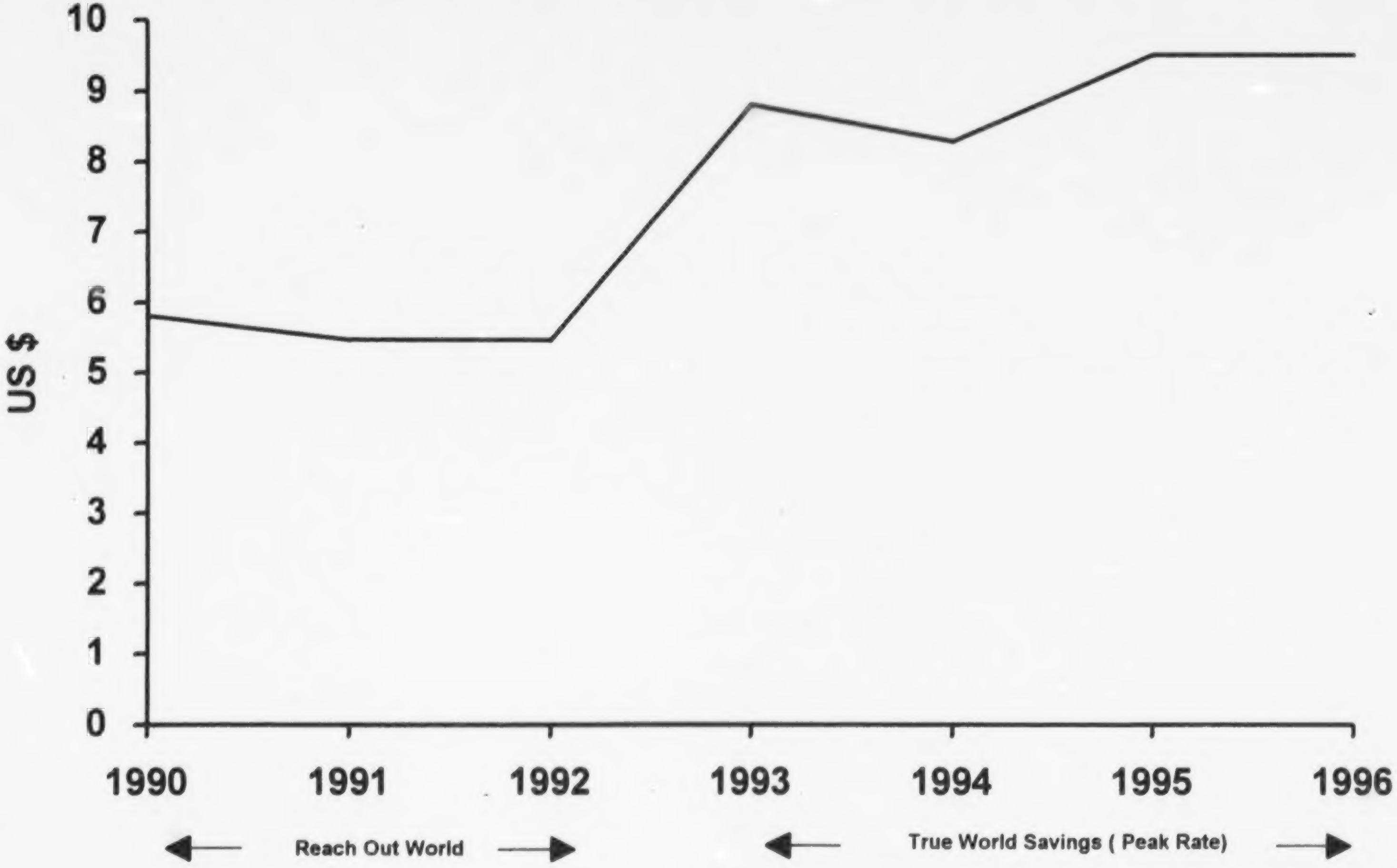
AT&T Rates for Direct-dialed calls to Hong Kong Lasting 7 Minutes during the Standard Rate Period (1982 - 1996)



Source - FCC International Trends Report, August 22 1996

Chart 4

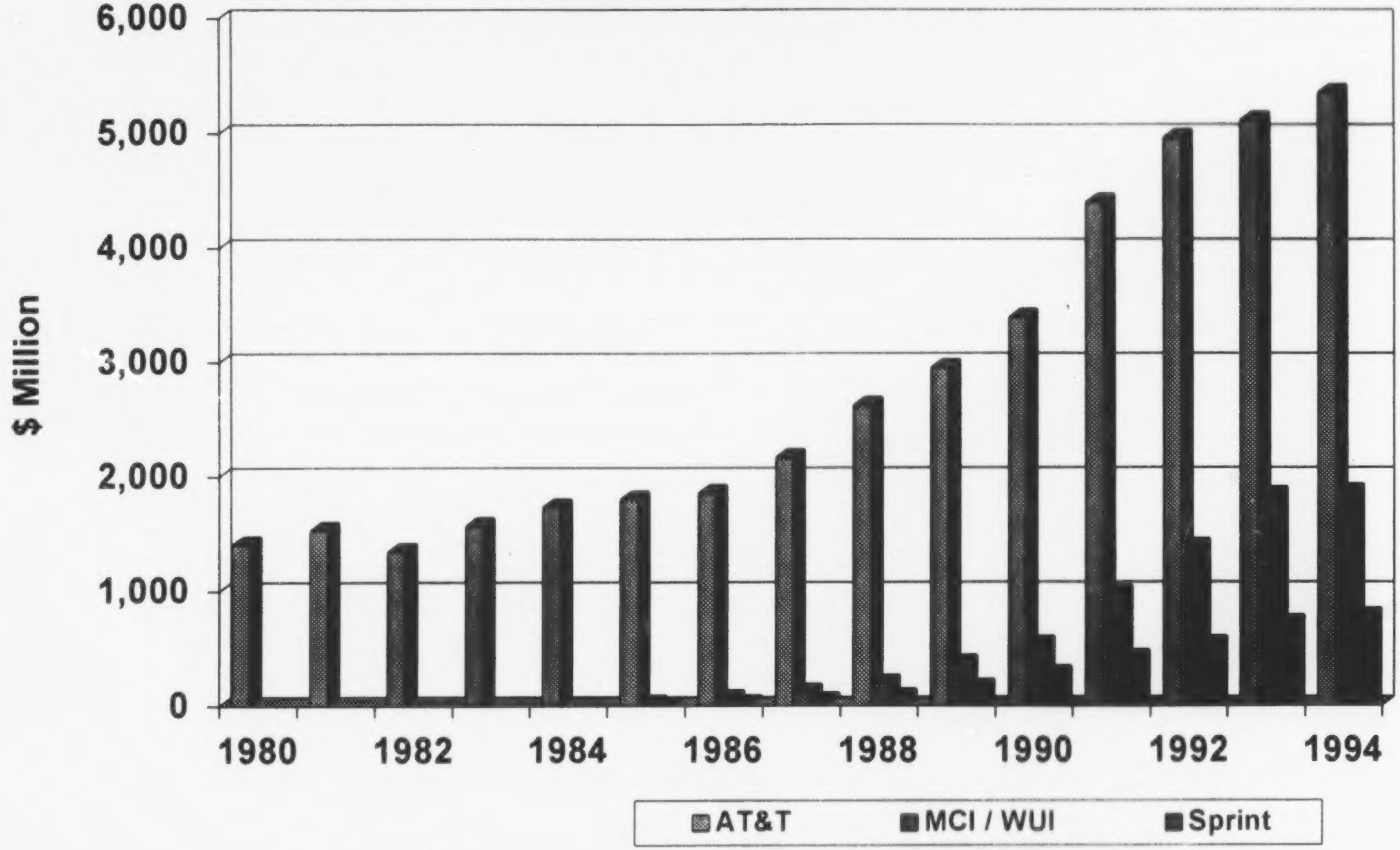
AT&T Discount Rates for Direct-dialed calls to Hong Kong Lasting 7 minutes (1990 - 1996)



Source - FCC International Trends Report, August 22 1996

Chart 5

Net Revenue from International Services (1980 - 1994)



Source - FCC International Trends Report, August 22 1996

correspondent are not neutralised by other reductions but merely transferred to US carriers.

Internal

Beyond these external pressures that are on the horizon, the local regulator, OFTA, has been very active.

In what will be a surprise to many in the audience, recent regulatory developments place Hong Kong at the forefront of telecommunications liberalisation, ahead of the UK, Australia and even the US. This liberalisation is of particular significance due to the time period in which it has occurred as the first competitors were licenced to compete with Hong Kong Telephone in July of 1995. Despite this short time period, the outstanding issues, at present, are surprisingly not the standard "bottleneck" concerns but rather the lack of regulatory response to the elimination of these bottlenecks.

Hong Kong Telephone Company Limited (HKTC) has played its role in facilitating contestability in the market place. International comparisons are drawn to indicate Hong Kong's progress in the liberalisation of the telecommunications industry. Additional liberalisation is necessary, however, as the regulatory regime has not fully taken these developments into account and is hindering the operation of, what would otherwise be, a fully competitive market.

THE DEVELOPMENT OF COMPETITION

The Office of the Telecommunications Authority (OFTA) issued three new Fixed Telecommunications Network Services (FTNS) licenses in July 1995. The newly liberalised environment allows competition in the provision of local telephone services, including the delivery of international calls.

Both the international and local telecommunications markets have seen significant liberalisation.

INTERNATIONAL

On April 23, 1996, OFTA released an 'Interpretation of the exclusivities of Hong Kong Telecommunications International. The paper stated that, in addition to the previous liberalisation of :

- Self-provided networks
- Callback (an IDD substitute service) and
- International Value-Added Network Services

in the future, liberalisation would extend to :

- International Simple Resale (ISR) for fax and data
- Virtual Private Networks
- Mobile -Satellite Services, and
- Video-conferencing

This liberalisation of the international market - along with three digit dialing for indirect access - has fully opened the IDD market to competition. The only exclusivities that remain for HKTI are the ownership of the international network and the prohibition on voice ISR so that all voice IDD calls must pass through the HKTI international gateway switch. Even in this instance, however, HKTI is required to pay a "delivery fee" to the local operator. In the case of an IDD call which utilise callback, this arrangement results in HKTI paying the operator a net amount for using HKTI's network.

LOCAL

For the local market, liberalisation has been even more extensive to the point that this market is fully contestable. Since the inception of competition, equal access has existed for access to the international gateway. Number portability was made available after 4 months of liberalisation. Collocation in HKTC's exchanges is provided along with unbundled local loops. HKTC has completed several customised commercial agreements with the new FTNS operators who have installed equipment in the HKTC exchanges. Interconnection charges are being negotiated and the agreed charge will be retroactive. However, operational interconnection has been fully implemented since the FTNS licenses were granted, even without financial agreement. Essentially, the "bottleneck" disintegrated within the first year of competition.

Recognition of these developments lead OFTA to issue a Draft Guidance Note entitled "The Enforcement of the FTNS (fixed telecom network service) Tariffing Rules in a Developing Competitive Environment" ("Pricing Flexibility Paper") on 1 June 1996.

This Note proposed minor modifications to the manner in which the tariffing provisions of the FTNS Licence are applied to HKTC, such as the use of FDC as a standard for pricing (a concept that is obselete in other liberalised regimes) and a requirement that volume discounts be cost-justfied (another obselete concept).

A HONG KONG COMPETITIVE CHECKLIST

OFTA has developed a "competitive checklist" as a means of testing whether or not a "bottleneck" exists at the local loop. This is equivalent to testing the contestability of the market.

The United States is the only other jurisdiction in which a competitive checklist has been used for regulatory purposes and this is a very recent phenomenon. A competitive checklist is incorporated in the *US Telecommunications Act 1996* in the context of the provisions that identify the pre-conditions for the Regional Bell Operating Companies ("RBOCs") offering long distance telephony services within their franchise areas (known in US as inter-LATA services). Effectively, an RBOC that is able to meet the necessary preconditions under the checklist is given the benefit of regulatory relief and access to the long distance market.

The checklist addresses the power - or lack thereof - of the incumbent operator in controlling "bottleneck" facilities. As the bottleneck is eliminated, the market becomes "contestable" and the incumbent is entitled to various forms of regulatory relief to allow it to fully compete. In doing so, the public policy objective of bring the benefits of competition to the public is achieved.

HKTC's COMPLIANCE WITH THE HONG KONG COMPETITIVE CHECKLIST

HKTC has cooperated in creating the conditions for the new FTNS operators to have an equality of opportunity to compete. The Hong Kong Competitive Checklist establishes clearly that HKTC has met the requirements for an open and competitive telecommunications market in Hong Kong.

OTHER COMPETITIVE JURISDICTIONS

Despite the fact that Hong Kong's fixed network telecommunications market has been liberalized for only since July of 1995, the implementation of liberalizing initiatives in Hong Kong has already matched, and in many respects exceeded, other jurisdictions. Table 1 presents the international comparison.

Many of the criteria are compiled with in all jurisdictions. However, the other jurisfdictions are not as advanced as Hong Kong, particularly in the development of the offering of unbundled local loop and number portability.

However, although Hong Kong market contestability conditions are more developed than the other jurisdictions, HKTC's degree of pricing flexibility(even that proposed by OFTA) is much less than is available to other incumbents. This incompatible degree of contestability and pricing flexibility undermines HKTC's ability to address the market and, importantly, the transfer of the benefits of competition to customers.

PRICING FLEXIBILITY - PRICE RELATIVE TO COSTS

The role of retail pricing is significant in giving the correct signal to attract efficient market entry and to achieve maximum consumer benefits. HKTC should be permitted to set prices as low as Long Run Average Incremental Cost (LRAIC). Any competitive benchmark test should depend upon whether the activity has the purpose or effect of preventing or substantially restricting competition. OFTA has proposed, however, a price floor of FDC. This will not result in economic efficiency. The pricing flexibility proposed by HKTC has been applied to the dominant carriers in other jurisdictions when their market contestability was substantially behind HK's current liberalized market environment, without damaging the development of competition.

In the US, pricing flexibility was permitted to AT&T in the mid-1980's. In 1984, for private line services, the FCC recognized that there was public benefit in implementing price flexibility for AT&T which was subject only to an anti-competition standard. The US long distance market at that time would not have passed the checklist that Hong Kong currently meets.

Table 1

Category	Hong Kong	United States	United Kingdom	Australia
Type I Interconnection	Yes	Yes	Yes	Yes
Type II Interconnection	Yes	Court stay of FCC order	No	No
Facilities Sharing	Partially	Partially	Only Mercury, not with other operators	Partially
CLI	Yes	Yes	Yes	Yes
Directories	Yes	Yes	Yes	Yes
Equal IDD access	Yes	Yes	No	Yes
Number Portability	Yes	No - FCC decision	No - currently being implemented	No - position being finalized
Resale	Yes	Yes	Yes	Yes

The UK regulator, OFTEL, adopted a similar policy. OFTEL permitted pricing flexibility to BT in 1991 with the approval of call plans.

In Australia, only tariffs which involve a market incumbent setting a price below Total Service Long Run Incremental Cost (TSLRIC) will generally be seen as having the purpose or effect of deterring or delaying entry. If testing against FDC data indicates that there are concerns regarding the predatory nature of a particular price, AUSTEL will require the dominant carrier to submit TSLRIC information to support tariffs.

These jurisdictions focused upon a principle which requires only the prevention of those activities by the incumbent that damage sustainable competition. Hong Kong's regulatory regime - which also advocates economic efficiency - should implement a marginal cost standard that gives the proper pricing signals.

CONCLUSION

On the external front,HKT is watching the FCC proceeding with interest. Any proposal for a unilaterally imposed set of benchmarks that probably violates ITU Regulations and would serve to bolster the growing US position as a - possibly the- hub for international traffic must be reviewed cautiously by HKT and other non-US carriers.

A multilateral approach, handled within the confines of the WTO or ITU, seems to be a far better model for reforming the accounting rate system

On the internal front, HKT supports the earlier decisions by the FCC, OFTEL and AUSTEL which emphasize that the economic logic of maximizing consumer benefit, promoting sustainable competition and achieving economic efficiency are the fundamental criteria in their review of discounts/price discrimination tariff. The dominance of the incumbent, even with pricing flexibility, has not deterred the development of competition. Rather, competition flourishes in those liberalised markets where pricing flexibility has been allowed.

The regulatory initiatives developed by OFTA as embodied in the checklist, along with implementation by HKTC, have created a market that is already highly competitive and fully contestable. In this setting, the pricing and service flexibility proposed by HKTC is appropriate and, in fact, necessary for maximum consumer benefit to be achieved.

On balance, it is clear that a great deal has been accomplished in Hong Kong in a brief amount of time.

A properly structured, multi-lateral reform of the accounting rate system will add to the dynamism of the telecommunications industry in South East Asia.

The final necessarly element of liberalisation in Hong Kong - pricing flexibility for the incumbent will complete this positive picture.

The Future of Hong Kong's Global Connectivity

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ABSTRACT

In this document and the accompanying visuals, we examine three areas—a) the current and prospective nature of international telecommunications traffic flows (for both switched voice and leased capacity) within Asia, b) the importance and characteristics of Hong Kong and China's position within regional traffic flows, and c) the potential impact of unfolding dynamics in Hong Kong among regulatory, private sector, and Chinese interests. Our objective is to outline critical issues and likely scenarios affecting Hong Kong's future global connectivity, a future which is likely to entail new players, priorities, and China as the key.

1. STRATEGIC CONTEXT

Hong Kong, along with Singapore and Japan, is rightfully regarded as one of the pre-eminent telecommunications markets within Asia. Considered by virtually any metric—teledensity, lines installed, digital network, wireless penetration, international business fax/data services, etc.—Hong Kong ranks as a premier Asian market. For a major carrier, PTT or otherwise, Hong Kong is an indispensable partner for correspondent relations and a source of significant international traffic and revenues. Not surprisingly, Hong Kong has been a critical component of regional cable and satellite facility planning.

Against this backdrop, we should note several looming factors which may threaten Hong Kong's position in regional telecommunications. Or, alternatively, provide Hong Kong with an unprecedented opportunity to expand its role in telecommunications infrastructure. Namely

- The obvious. July 1, 1997's restoration of Chinese sovereignty and the uncertainty it represents.
- The emergence of well-capitalized competition to HKTC, at least domestically in wireline and wireless and for "enhanced services".
- The likely end of HKTC's monopoly in international services.
- The continued dramatic growth in traffic within Asia, both from switched voice and internet/data/fax/VPN.
- Renewed interest in new transpacific cable facility construction prior to 2000.

The author has no crystal ball through which to predict the future. However, by separately examining likely prospective developments, many of which are "predetermined events" where only the timing and magnitude remain uncertain, and true uncertainties which remain as yet unknown, it may be possible to suggest prospective developments for Hong Kong's future connectivity.

2. ASIA TRAFFIC FLOWS

A critical piece in developing an educated view of the future in telecommunications requires projections of future demand. It is here however, that traditional network forecasting methodologies are insufficient. Most rely on historical demand, and base projections on regressions or exponential smoothing. Few ever link telecommunications traffic to its underlying drivers. This is particularly problematic in high growth markets and forecasts are invariably wrong, often frighteningly so, and are almost always far too conservative.

This is clearly insufficient for the world's most dynamic and rapidly growing region. At CSMG, we have developed an alternative forecasting approach which, although beginning with historical figures, develops future projections by linking demand to the four key drivers of traffic—GDP growth, trade growth, regulatory dynamics, and technology developments. Our proprietary model ***SMITH***, Simulation Model of International Traffic Horizons, has been used to assess the evolving dynamics

For this paper, I developed base case projections of international switched voice and leased capacity for all countries within North, South, SouthEast, and Austral Asia for the Year 2000. I have chosen 2000 since it remains within a reasonable planning horizon for decisionmaking in terms of facilities investments but is near enough to be sufficiently immediate. These are displayed on Figures 1 through 4. We discuss each in turn.

In Figure 1, we examine outbound international switched voice traffic projections to all regions of the world. Only countries with at least 5% of regional flows are shown separately. One fact is striking—China and Hong Kong will likely represent fully one-third of all international calling, each surpassing Japan. Further examination reveals that while traffic is highly concentrated, most countries send 40-50% of their traffic to the other regions in Asia with little calling to other regions, with the exception of North America and Australia to Europe traffic.

The dramatic concentration of Hong Kong and China traffic to what we have characterized as North Asia is remarkable and Figure 2 provides the answer. Today, and perhaps even prospectively China-Hong Kong and Vice Versa traffic is classified as international calling. More than 60% of each regions calls are likely to be country pair in 2000. Prospectively, such traffic may well be treated as what it is, which is essentially long distance trunk traffic, and an examination of the "true" international calling patterns bear some further investigation.

Figure 3 examines the same set of data but excludes "domestic" traffic. Two important notes should be made. First, the relative share represented by each "country" has fallen significantly, although taken together the remain the largest ever so slightly. Second, the calling patterns of each show distinct differences. Hong Kong's traffic is more balanced within the region and is, as one would expect, likely to be more heavily weighted toward SouthEast Asia. China's flows remain highly focused on North Asia. We will explore the implications of this in a later section.

In Figure 4, we focus our attention on leased capacity for internet, data, VPN, and other so-called "private-line services." Not surprisingly Japan (given the extended manufacturing base) and Australia/New Zealand (given internet, etc.) traffic is large. However, the relative importance of such service in China remains quite low, even with aggressive growth rates. Hong Kong's traffic is highly concentrated to Japan, with over 50% of leased capacity projected.

3. HONG KONG AND CHINA

What are the existing key facts and emerging undercurrents in Hong Kong and China as it relates to telecommunications?

- C&W currently occupies a preferred position in Hong Kong and perhaps in China
    - Ownership of HKTC
    - Sole license holder internationally in Hong Kong
    - Only Hong Kong or China stakeholder in oceanic fiberoptic cable systems—4 transpacific and 10 within SE Asia. China essentially has no ocean cable investments.
    - Agreement with Chinese authorities for potential new transpacific cable systems and other telecom projects.
- However, this preferred position is being undermined
    - Pressure to buy-down C&W below 50%.
    - Continued OFTA deregulation of Hong Kong telecommunications markets for "enhanced voice"
    - Wireless licenses were granted in such profusion that some wonder if this was done as a signal to C&W/HKTC of OFTA's displeasure
- Pressure from AT&T and the FCC to dramatically lower accounting rates, and thus net settlements, well beyond current agreements (thus striking at the heart of HKTC and C&W profits).
- As we all know, US carrier net settlements are a significant source of foreign funds
- Renewed interest in new transpacific cable facility construction prior to 2000 with at least 4 projects on the drawing boards.

4. PERSPECTIVES ON THE FUTURE

Given the above, what are the likely dynamics for Hong Kong and China and what is the likely effect on global connectivity?

The situation in Hong Kong can actually be viewed as fairly straightforward, with the main theme being that Hong Kong is clearly an attractive market, and will certainly be a key linkage in future cable and satellite endeavors. However, the major scenarios and potential opportunities are as linkages and stepping stones to China and will involve a new set of entrants.

The key issue is C&W's/HKTC's international monopoly license until 2006 and the likely moves that could be played out by the new players. Since domestic second licensees and other new entrants, *may be unable* to secure a full-fledged international license within a reasonable timeframe, we *may* see a dramatic new set of decisive actions that will open up Hong Kong and China's global connectivity in an unprecedented fashion.

Expect to see a Singapore-like buy down of the monopoly to 2000, 2001 or 2002. 1999 seems too soon to most observers – only 18 months after 7/1/97. Likely event: C&W will be bought down to less than 50%,

Parties best positioned to fill in gap will be: Hutchison, Wharf, New World, CITIC, China Resources. What are some likely moves that we could see once they have international "options" or post 1997?

- Close partnerships, joint ventures, equity investments between and among Hong Kong and China interests
- Membership in a major global alliance (GlobalOne, Concert, even World Partners?)
- Provider of landing rights for new cable landings in Hong Kong (e.g.: SE-ME-WE3)
- Sponsors of new transpacific cable(s) with China. landing(s). Several proposals exist.
- Expansion of satellite interests given China's geography within and beyond ChinaSat, AsiaSat for "greater China" communications services.
- Ownership stake in "nearby" or heavy bilateral traffic markets to Hong Kong and/or China–Singapore, Korea, Japan–via second licenses or PTT privatizations.

5. CONCLUSIONS

Fundamentally, up to this point Hong Kong's connectivity, especially from a cable perspective has been one of monopolistic control both in terms of Hong Kong and access to China.

Prospectively, the dynamic of facilities connectivity will change as in Figure 5, whereby a myriad of forces and multiple players vie for facilities planning, investement, and control. In short, Hong Kong as an end to itself will be less the attraction for facilities projects. However, Hong Kong as a means to an end and Hong Kong parties as key facilities players will become the rule post 1997, with increasing dynamism in the international facilities arena.

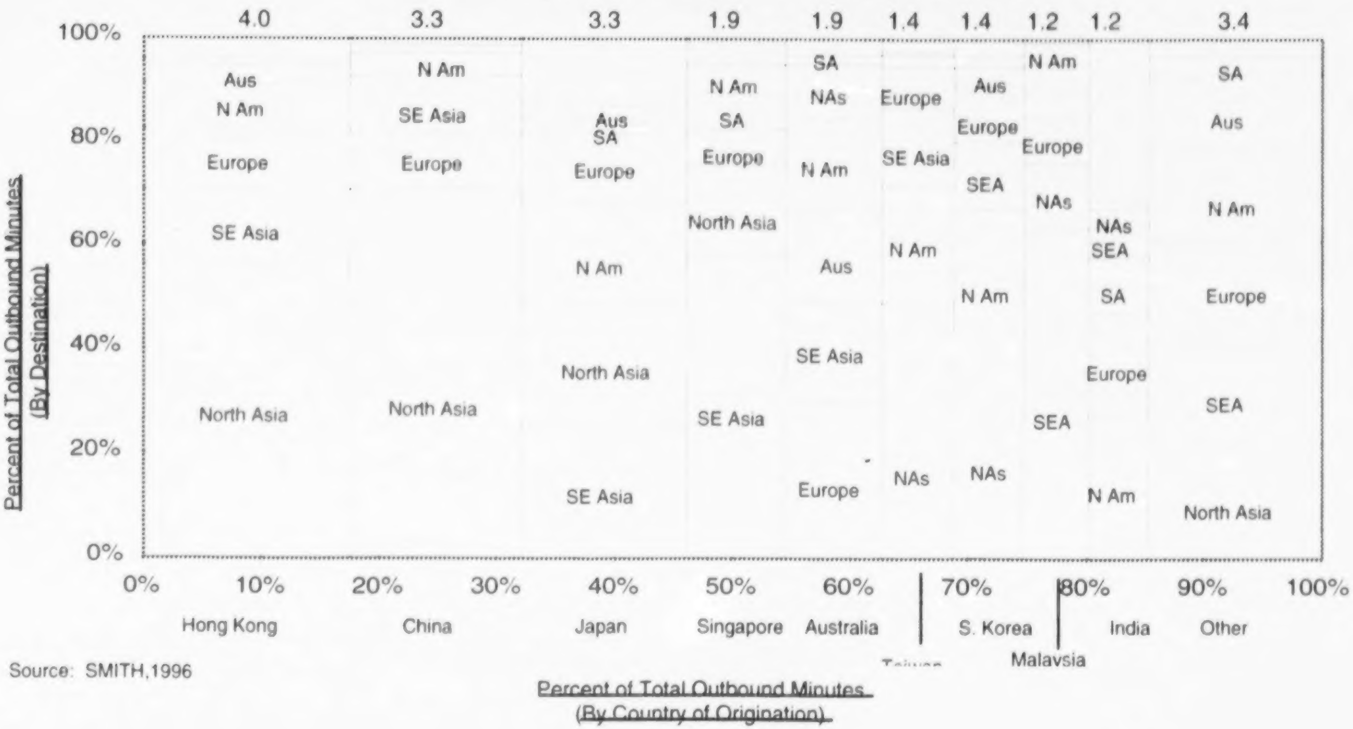
The question becomes: who will agressively pursue the opportunities as the unfold and explore non-traditional arrangements and who will miss the opportunity to establish a strong international foothold given the changes afoot?

Asia Traffic Flows 2000 to World Regions

Figure 1

Asian outbound international traffic is highly concentrated in a few countries, and Hong Kong and China appear to have the largest positions

Year 2000 Total International Minutes = 23.1BB



Source: SMITH,1996

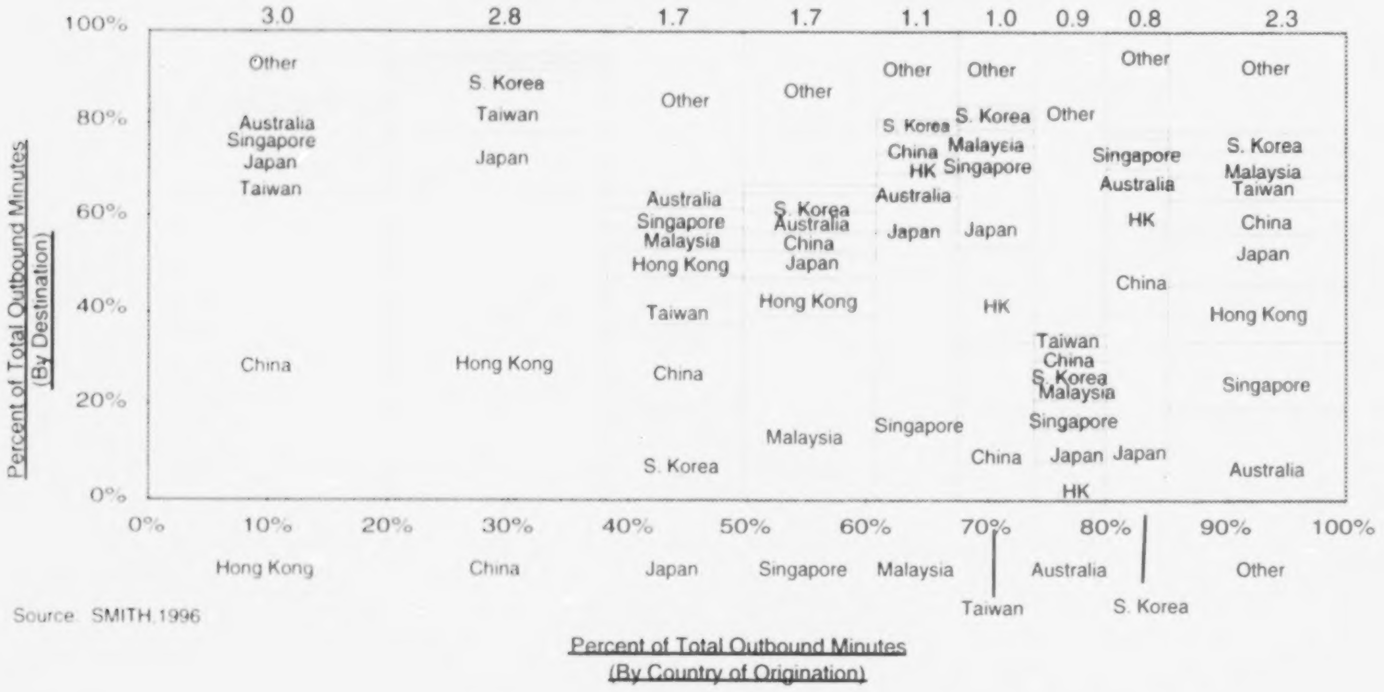
Asia Traffic Flows 2000 to Asian Countries

Figure 2

However, intra-Asian patterns are decidedly "bilateral" in nature and highly concentrated.

- The distortion caused by HK-China "soon-to-be domestic" traffic is clear

Total International Minutes = 15.2BB

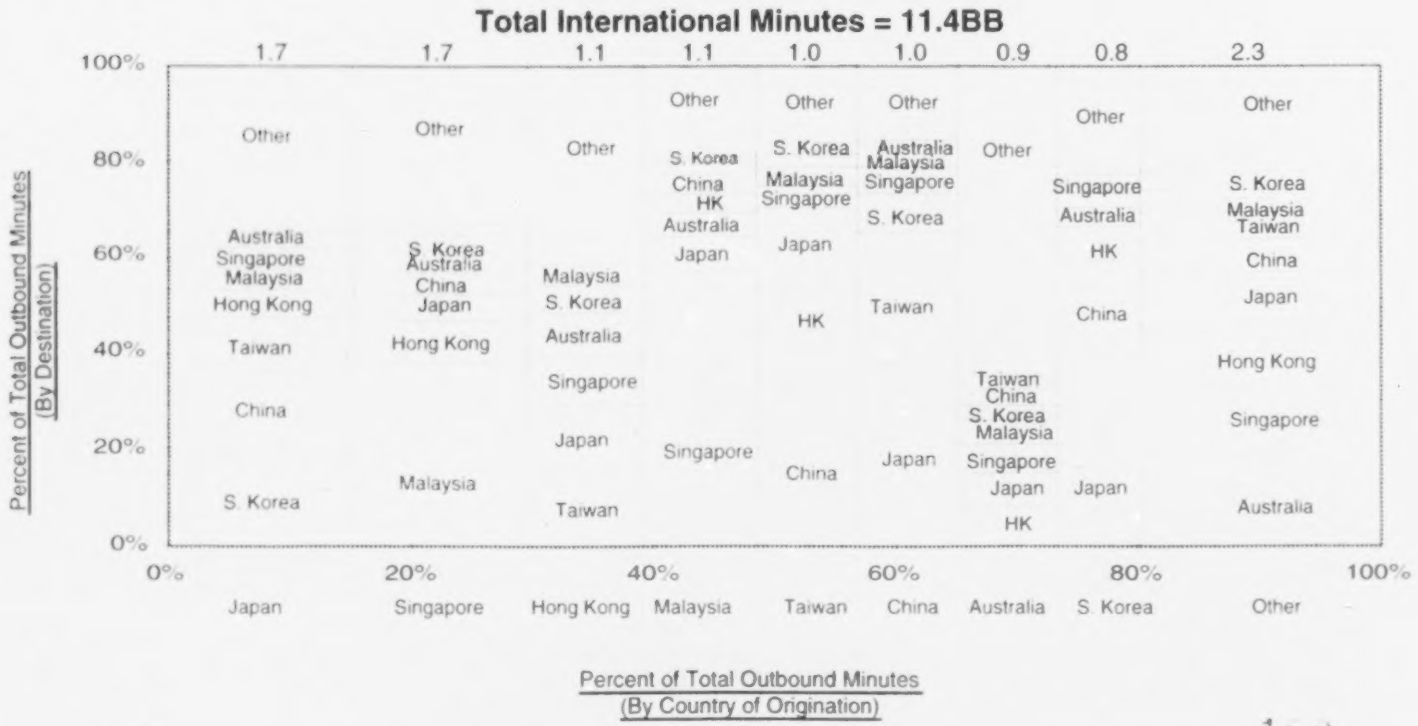


Source: SMITH 1996

Asia Traffic Flows 2000 to Asian Countries

Figure 3

When "domestic" traffic is removed, Japan and Singapore emerge as the major traffic centers with Hong Kong a solid third and China sixth.

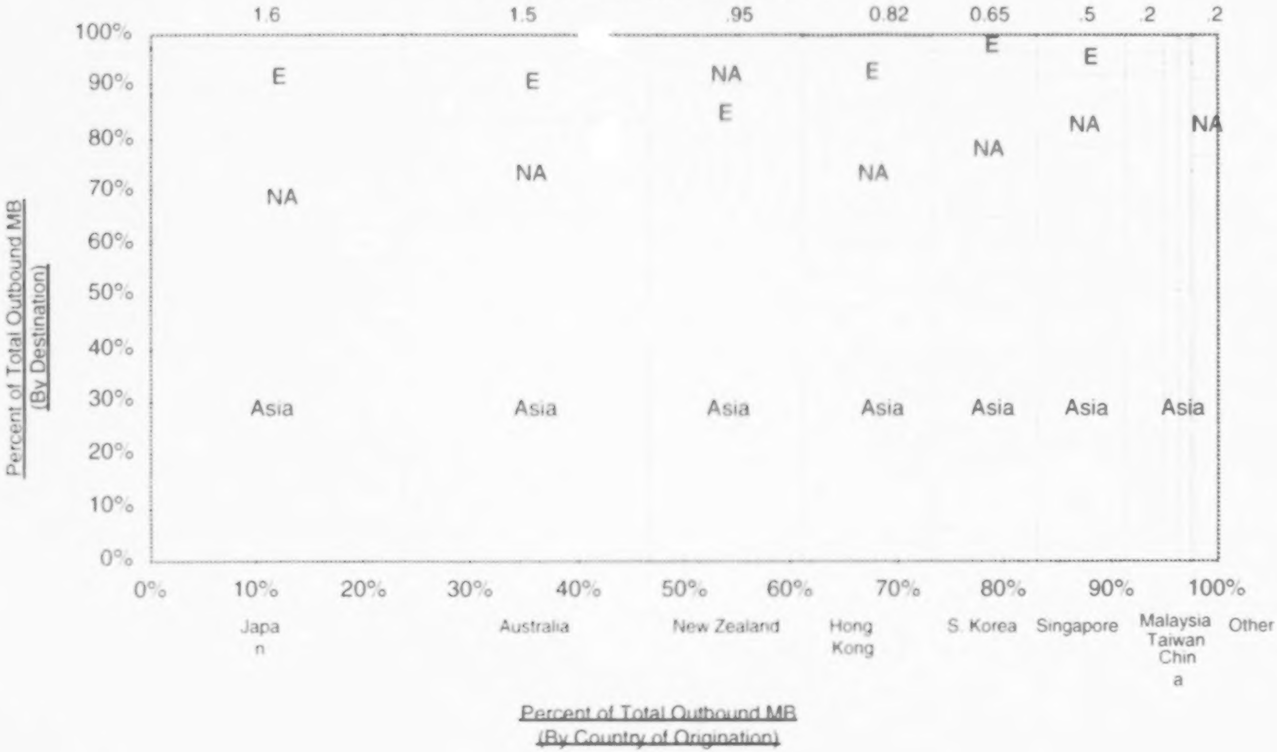

Total International Minutes = 11.4BB

Asia Leased Capacity 2000 to Asian Countries

Figure 4

The dynamic for leased capacity is also highly concentrated with, as expected Hong Kong a major player and China less significant. The major portion of Hong Kong's leased capacity within Asia is to Japan (50%), Korea, Australia, and Singapore.

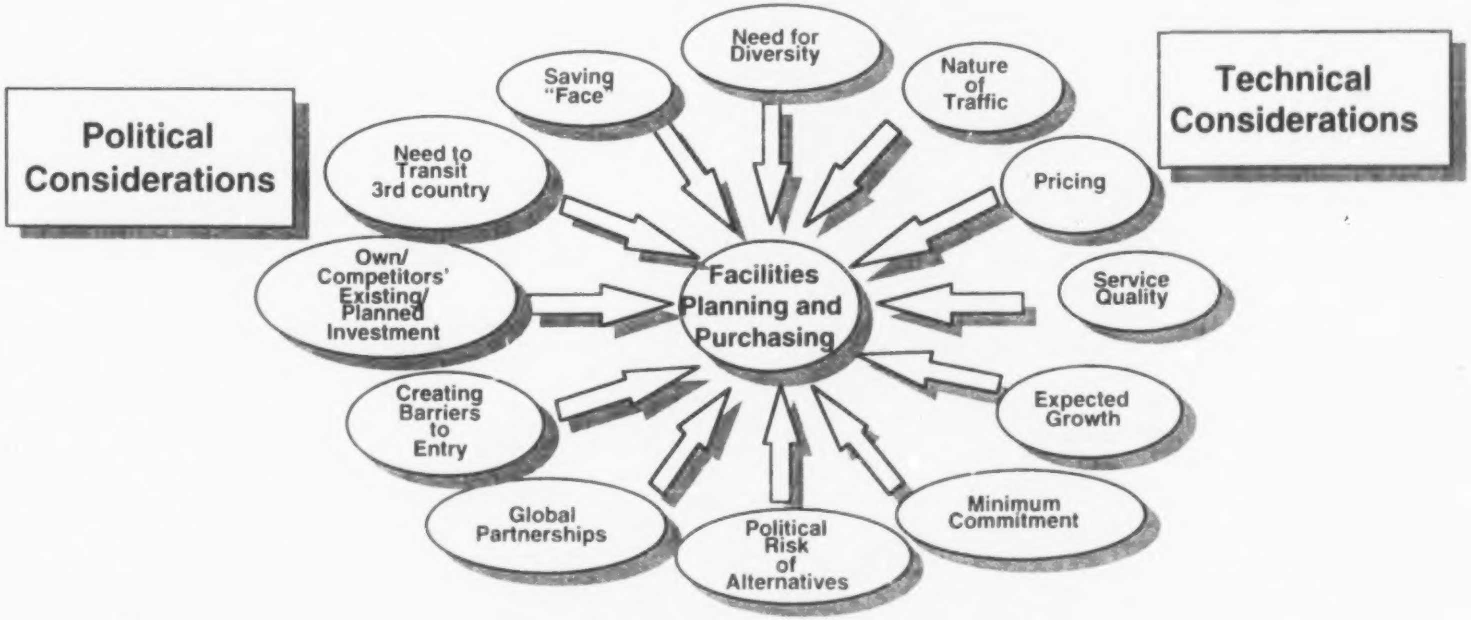
Total International MB =6,573



Key Facilities Planning Considerations

Figure 5

Facilities planning in Hong Kong has—to date—been driven by HKTC and access to China. Prospectively, in our view, international facilities planning and purchasing decisions will become a mix of technical and political considerations.



Political Considerations

Technical Considerations

Facilities Planning and Purchasing

Saving "Face"

Need for Diversity

Nature of Traffic

Need to Transit 3rd country

Pricing

Own/ Competitors' Existing/ Planned Investment

Service Quality

Creating Barriers to Entry

Expected Growth

Global Partnerships

Political Risk of Alternatives

Minimum Commitment

Current Uses in the Asia Pacific Region of
SATELLITE TELEVISION
by Corporations

MICHAEL FLECK
Global Vision Satellite Services
Sydney, Australia

ABSTRACT

A short overview of Business Television in the Asia Pacific region. A review of current activity by multinational companies in both permanent networks and 'ad hoc' events. The paper also highlights some regulatory and resource impediments to the development of this new market in the region.

1. OVERVIEW OF BUSINESS TELEVISION - *to establish how it is different from broadcast television and the services required*

1.1 BACKGROUND

Business Television networks are secure and private television services linking a company's branch offices, warehouses, factories, etc, to a central point. Corporations, governments and institutions use business television to deliver staff communications, training materials and marketing information **LIVE** to people no matter where they are located. Organisations can reach all their people at the same time with the same message.

Infrastructure requirements at the 'receive sites' are minimal. Each location in these networks is equipped with at least a TVRO satellite antenna and receiver/decoder, or IRD. They give corporations and others an effective and economical method of conducting live events by satellite.

Further, the relative ease with which receive sites can be installed means that corporations can rapidly deploy satellite networks and include even the most remote locations from the outset. BTV networks are used for distributing a wide range of programming including:

☑ Training
☑ Direct marketing seminars
☑ Sales conferences
☑ Product launches
☑ Management information

True BTV uses broadcast quality television images. It is not to be confused with videoconferencing which uses telephone or ISDN lines to deliver comparatively low quality images. While BTV delivers vision in one direction only, from source to receiving sites, interaction is readily available via normal telephone handsets or the Internet. BTV uses the same technology as the CNN program, *Larry King Live*, and in the same way.

BTV is television. The creation and distribution of BTV programming uses the same technology and services as TV broadcasters. For BTV to work it requires:

☑ Cameras, studios and 'talent'
☑ Microwave and fibre optic links
☑ Digital compression and conditional access systems
☑ Uplinks
☑ Broad band transponder capacity
☑ Downlinks with decoders and mini cable distribution networks

Diagram One Here

The infrastructure is that of broadcast television. However, there is a key difference between broadcast television and business television - broadcasters are full time users while corporations are part time users. Further, broadcasters generally transmit from a single central location to all receive sites. Corporate users often have a number of locations from which to transmit. These may appear to be small matters, but they are the key to understanding why business television is so slow to take off in Asia.

1.2 BROADCAST VS CORPORATE

Where the broadcaster can almost always justify operation of full time facilities, it is a rare business user of satellite television which can do the same. Corporate users therefore require access to broadcast services part time only. Those of you who are familiar with the US and European markets will know that this is not a major issue in these markets. There is ready access to a large number of competitive suppliers of all these services. In the Asia Pacific region it is a very different matter.

It is important to state at the outset that all the services and facilities needed for BTV exist in the region and are generally of a very high standard. The issue is not one of standards or technology, but of availability and understanding. As we will see, the BTV industry is growing rapidly even in the countries of Europe and North America.

If corporations, governments and individuals of the Asia Pacific region are to make use of this extremely powerful medium, service providers will need to recognise that the needs of BTV users are different from those of broadcasters and adapt their services accordingly.

Before going on to an outline of the current state of infrastructure in the region as it relates to business use of satellite television, it would help to digress briefly and discuss the size of the industry worldwide to show the potential market within the region.

2. STATUS OF BUSINESS TELEVISION INTERNATIONALLY - *the major markets and players in the US, Europe and Asia, where the market is headed in Asia*

Business television began over 20 years ago when Hewlett Packard began training and sales communication live by satellite in the US. Since then over 150 corporations and government bodies have installed BTV networks in the US.

2.1 US CORPORATE NETWORKS

The range is a s wide as business itself, eg:

☑ 3M
☑ Aetna Life and Casualty
☑ Air Force Institute of Technology
☑ Boeing
☑ Dominos Pizza
☑ Eastman Kodak
☑ Federal Express
☑ Ford
☑ Merck Sharpe and Dohme
☑ Texas Instruments
☑ Wal Mart

These are just a very few American networks. There's many more and most have expanded or are expanding to Europe. They are private satellite networks, set up by these organisations for use by them in reaching their personnel.

2.2 US PUBLIC NETWORKS

In addition, there are *Industry Networks* and *Public Networks*. The most well known of these have been established by Westcott Communications and include full time services that transmit to industries like:

- ☑ Law Enforcement
- ☑ Fire Brigades
- ☑ Motor car dealers
- ☑ Private Investigators

These industry networks usually transmit eight hours a day, five days a week. Others, like the new Ford network, FordStar transmits five channels simultaneously delivering in excess of 150 hours of programming a week to Ford locations.

Combined, business television in the US consumes well over 70,000 hours of satellite time every year. That represents over 1,000 hours a week. So it is clear that this is potentially a large market in Asia.

2.3 OUTSIDE THE US

Outside the US the industry is not as wide spread, but is growing. In Europe users include:

- ☑ BMW
- ☑ British Airways
- ☑ HM Customs (UK)
- ☑ ICI
- ☑ Ideal Hardware
- ☑ Lloyds Bank
- ☑ Mercedes
- ☑ Norwich Union
- ☑ Oracle
- ☑ Virgin Megastores

In the Asia Pacific region, there are only two countries active in this area of satellite television: Japan and Australia. Of the two, Japan has the most networks and the most sophisticated networks with over 40 corporations having their own systems. One of the largest users is Mitsubishi which transmits over 200 hours a week.

In Australia there are a number of BTV type networks funded by the government, primarily for distance learning, but corporate use of BTV is rare. The exception is the Commonwealth Bank which commenced installing a network that will exceed 1,200 sites across Australia.

3. GROWTH CYCLE FOR BTV - *the start and services needed to allow it to thrive*

3.1 INFRASTRUCTURE NEEDS OF BTV

If we examine how business television has grown up, it is apparent that a number of factors are required before demand can be stimulated and satisfied. In each region where BTV has been a success all the following have been in place:

- ☑ Well developed television production industry
- ☑ Access to **part time** satellite services including
    - First mile connections
    - Encoders / Uplink
    - Satellite capacity
- ☑ Experienced commercial satellite downlink installers
- ☑ Systems integrators

In addition, these services need to be available for 'trial', ie a no capital commitment period of use so companies are able to test the technology without capital investment.

3.2 FIRST STEP

Generally speaking companies first test the system through the use of public facilities such as downlinks in hotels and conference centres. These venues are hired for a short period of time, for example a day or even a few hours.

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Television production is contracted out and systems integrators arrange for connections and satellite capacity.

A typical use will be a product launch in which customers are invited to attend in a location near where they live. The event is transmitted live from a central location to all sites so the new product or service is in the market quickly and at less cost than the traditional 'road show'.

With this success, corporate management investigate other uses of the technology, again without investing capital and using public facilities. Once management have had the opportunity to 'play' with the technology three to five times, they generally commit to a permanent network of their own with varying degrees of fixed production and link facilities.

Without access to the full range of occasional services, an Asia Pacific business television market cannot develop. Certainly, Asian corporations can see what is happening in this field in the US, Europe and Japan, but without easy and economical access to services, they cannot try for themselves. This leads to the overall feeing that somehow BTV is not for Asia since the services are not here.

4. CURRENT STATE OF INFRASTRUCTURE IN ASIA PACIFIC - *availability of the various components and some factors restricting the market*

4.1 REGIONAL SATELLITE SERVICES

In fairness to regional service providers and Asia based corporations, a true regional business television industry was not possible before the end of 1994. This was the time that the PanAmSat satellite PAS 2 came into operation. Until this time there were no satellites suitable for regional BTV transmissions.

Prior to this time, capacity was either on domestic satellites (such at those in Japan and Australia which allowed the domestic BTV usage to grow) or Intelsat satellites which were not designed for point to multi-point services. Intelsat services were:

☑ Low power
☑ Difficult to access
☑ Very expensive

The remaining satellites covered only a part of the region often making it necessary to use several satellites to cover the Asia Pacific.

While there are now a plethora of satellites offering wide regional coverage, a further and (still difficult) problem is that most satellite operators do not support occasional access to transponder capacity. It is not viable for us, or anyone else, to design and install corporate networks based on defined satellite capacity if there is no guarantee that that capacity will remain available. The best most satellite operators will offer is short term, pre-emptible space segment. For BTV networks, it is worthless.

PAS 2 changed all that. For the first time, there is coverage of the entire East Asian region and most of Oceania with a single transmission. The power is high enough to get a signal into most locations with a 3.0 metre antenna. This may seem large, but when the earlier alternatives were over 5 metres, it is a joy.

PAS 2 also has the feature of allowing direct connection from the US - remember this is home to most BTV users - into Asia. Finally, PanAmSat has made occasional access a fixed component of their service, encouraging design of permanent business television networks in Asia.

4.2 ENCODING

A further complication is access to encoding equipment. Most corporate users of satellite television services do not want their competitors watching their internal communications. This means that encryption and conditional access are critical to BTV.

(There is not space here to enter into discussions about the recent history of the digital compression saga. Suffice to say that they were trying times for the lowly BTV user as well.)

A more fundamental problem is part time access to conditional access systems at all. Remember that satellite television services historically were for broadcasters who would purchase their own encoders and install them at the prime uplink location. When we began developing serious BTV applications immediately before and after the launch of PAS 2, there were no conditional access encryption services for occasional users anywhere in the region. This made designing systems rather tricky since users in the early stages will not commit the capital for a dedicated encoder. Usage rates in the first year or so are usually only 5 - 10 hours a month.

PanAmSat soon changed this a little with the first Scientific-Atlanta digital (MPEG 1.5 as we called it) MCPC platforms in the Los Angles area and in Hong Kong. This allowed secure programming to be delivered from the US and Hong Kong to regional sites.

It is a constant problem and one which will only be resolved when more players begin to offer satellite services.

4.3 TERRESTRIAL INFRASTRUCTURE

There are three key constraints which must be overcome in each and every potential origination location:

1. We cannot use a satellite if we cannot access it with uplinks available on an hourly basis.
2. We cannot connect to uplinks without temporary microwave or fibre connections.
3. We cannot create programs without modern and reasonably priced TV production services.

All components of the package must come together before a regional BTV market will emerge. We would like to briefly review the state of what we call the 'Terrestrial Infrastructure' for BTV.

4.4 TELEVISION PRODUCTION SERVICES

Most countries are reasonably well supplied with TV and video production services - for broadcast or videotape that is. There are very few organisations which can supply professional live TV production.

There are basically two types of live production, 'studio' based and 'location'. Of the two, studio is the most used because it is the easiest. It involves access to normal TV studios when they are not in use by broadcasters.

The main problem in this aspect of BTV is cost. For example, in the US a fully equipped two camera studio with crew and control is readily available in most cities for about US$1,200 per hour - and they are available by the hour. Prices for comparable services in Asia are roughly:

US$1,400 an hour in Australia
US$1,700 an hour in Hong Kong
US$2,350 an hour in Singapore

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US$3,100 an hour in Taiwan
US$4,000 an hour in Tokyo

Another major difference is that in most locations (other than Hong Kong and Australia), these facilities are only available for a full eight hour day. An added expense if the customer only needs 60 minutes of program time.

4.5 'FIRST MILE' CONNECTIONS

This is the area where the problems really begin - connection from the place where the program is happening (like an office, a hotel ballroom or even most studios) to the uplink.

For years in Asia this type of connection has been the sole domain of the broadcasters and the PTT's. Again, these users run full time services. To obtain use of such facilities for a day or even less is not generally possible. The exceptions are Australia, Singapore and Hong Kong. The two primary technologies are microwave and fibre optic.

In major cities in Australia and in Singapore, microwave services are readily available and comparatively inexpensive at about US$2,500 per link per day. Fibre optic connections are more difficult to install so are not really an option for one day events. However, many locations in Australian cities are already wired and sell access to the fibre hourly or daily.

4.6 OCCASIONAL ACCESS TO UPLINK SERVICES

Once a production crew is arranged and the first mile connection sourced, the next problem is a suitable uplink. Those of you familiar with the US market will know that this is a matter of a single phone call. Rates are generally highly competitive and generally quite good value.

In the Asia Pacific region, most uplink providers are PTT's, PTT look-a-likes or broadcasters. Once again, broadcasters are full time users for their own services. The PTT's have had the Intelsat monopoly for so long that they so not know how to charge differently. The following current rates highlight the problem.

Per hour uplink costs rates are:

USA - PanAmSat Sylmar	US$ 225
Sydney (Optus)	US$ 600
Hong Kong	US$ 860
Singapore	US$ 1,275
Japan	US$ 2.066

Most pricing does not make a lot of sense since these are the same prices for uplink **and** half space segment for Intelsat services. Further, these suppliers generally charge the same for rates for both uplinking and downlinking an occasional signal. In many countries the cost of five hours downlink at these rates will purchase a complete downlink system.

The rapid growth in non-Intelsat services is already leading to an increase in alternative uplink sources. In most cases these new companies, like ST Teleport in Singapore, are offering modern services at modern prices. These will be the ones to benefit from this new market.

Others, clinging to the old glory days, will be left wondering about this new market.

4.7 GOVERNMENT REGULATIONS

Thankfully, there is little government interference in this field at the present time. We suspect this is probably due to the fact that there has been little activity so far to attract the attention of the regulators. Further, since we typically will use licensed providers of uplink and first mile connections, operational are well within the existing framework.

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As the volume of activity grows this will change. For now, there are few regulatory issues:

MALAYSIA

It is still difficult to obtain permission to install a downlink in Malaysia. This is in spite of the fact that the services to be provided by BTV users are perfectly consistent with the education and training goals of the government.

SINGAPORE

This is a curious place. Singapore is a major regional centre for TV production and satellite transmission, yet reception is severely restricted and tightly controlled. Applications for BTV use are treated with suspicion while the intentions are well accepted. To obtain a permit to operate a BTV downlink in Singapore, companies must pay a spectrum usage fee, usually about US$4,000 a year.

CHINA

While there are few restrictions on use of downlinks by foreign companies in China, they are required to obtain a license for IRDs. Further, uplinking from China is a continual challenge. While not necessarily illegal, it is restricted by lack of information and a difficult bureaucracy. Once again, the goals for most BTV users and the government are similar, it is just difficult to distinguish between satellite television and business television.

AUSTRALIA AND NEW ZEALAND

Surprisingly for those who do not know the countries, Australia and New Zealand can also be difficult places to install downlinks. This is not due to federal government policies any longer, but to local government restrictions on where and how antennas may be installed. It takes longer to install a BTV downlink in Sydney than in Beijing.

5. CURRENT BTV ACTIVITY IN THE ASIA PACIFIC REGION - *permanent networks, ad hoc events*

5.1 TYPES OF BTV ACTIVITY

As outlined above, there are two distinctly different types of BTV activity:

AD HOC	Usually special events that happen once only. Transmitted to 'public rooms' such as in hotels and conference centres.
PERMANENT	Regularly scheduled events (normally 2 - 20 hours a month) transmitted to fixed locations, generally at company premises such as offices or factories.

The bulk of the activity now happening regionally, as opposed to nationally, is in the form of Ad Hoc events.

5.2 AD HOC ACTIVITY ACROSS THE REGION

I can only speak for those that my firm is handling, but it will give you an idea of the level of activity and the rate of increase.

Table One

Each year the number and variety of originating sites increases as well.

Table Two

Over this period, events have ranged from one day training sessions to product releases to corporate announcements. These events are received directly from satellite into the hotels. All locations have function rooms and conference centres with permanently installed antenna systems and cabling.

Table One

	1994	1995	1996	1997 *
Number of Events	6.0	10.0	15.0	28.0
Average number of sites	2.3	4.1	4.9	6.0
Average total audience	73.0	197.0	146.0	120.0
Average duration (hours)	1.3	1.4	2.1	2.0

Table One

Ad Hoc' activity in Asia Pacific region, events managed by Global Vision. * denotes projections

Table Two

1994	1995	1996	1997 (projected)
Boston Orlando Tokyo Washington	Canberra Dallas London Melbourne New York	Boston Dallas Hong Kong London San Francisco Singapore Taipei	Bangkok Beijing Dallas Hong Kong London San Francisco Singapore Sydney Taipei Tokyo

Table Two

Ad Hoc origination locations 1994 - 1997 (projected)

This makes reception of the event a relatively simple business. We expect to see an dramatic increase in the use of this network for training over the next 12 months, especially in the medical, information technology and financial industries.

In addition, with the increasing access to appropriate terrestrial infrastructure in the region, the number of cities where it will be possible to originate programming is set to rise. Our company is now planning events from most major cities in the region, but there is still a long way to go to make the service readily available.

5.3 TEXAS INSTRUMENTS TELEVISION - TITV

To date there is only one true BTV network operational across the region, ie across borders. This pioneering firm set out to create a worldwide satellite television network covering all its 115 locations. Texas Instruments has now been operating regular live and interactive satellite television services in Asia since mid 1996.

'TITV' originates programming from the corporate headquarters in Dallas Texas. Recently the first transmissions from the Asia Pacific regional head office in Taipei went all around the world. We commence regular live programming from Taipei to the Asia Pacific sites in March.

The TI Asia Pacific network uses S-A PowerVu and is installed in :

☑ Australia - one site
☑ Chine - one site
☑ India - one site
☑ Japan - five sites
☑ Korea - one site
☑ Singapore - one site
☑ Taiwan - two sites
☑ The Philippines - one site

One site will be installed in Malaysia during first quarter 1997.

TI now transmits about 10 hours a month. They are presently installing the 'One Touch' interactive system and expect usage to rise to 15 - 20 hours a month by the end of 1997. The network is managed with monitoring services and help desk from Sydney.

TITV in Dallas has its own studio facility, but contracts out the equipment and crew functions to a local production company. They link via microwave to Dallas Fort Worth Teleport and from there connect by VYVX fibre to the US west coast where we uplink to PAS 2.

In Taipei, we lease a broadcast studio in down time and connect to Hong Kong for encoding and transmission to the network.

6. SUMMARY AND A PRAYER- *a plea to smooth the path and not waste an opportunity*

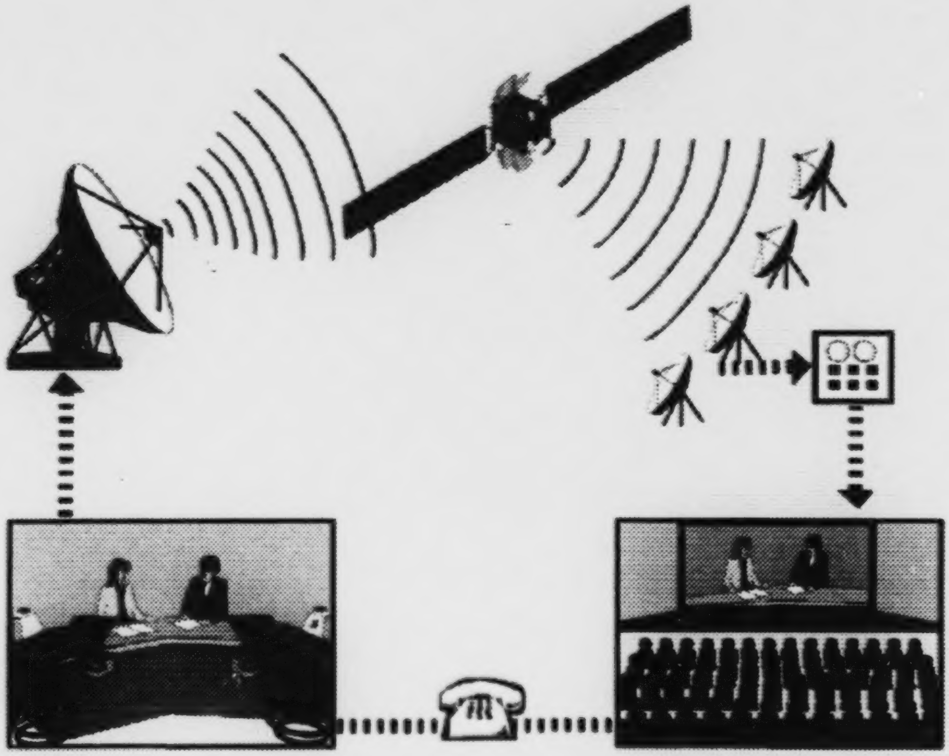
Today in Asia, business television represents a unique opportunity. An opportunity not only to develop a badly needed new market, but to benefit millions of people as well. The strength of BTV is in allowing one person to reach many people at the same time and with interaction. This alone can go a long way towards alleviating the enormous personnel and financial strain now being experienced by education systems across the region. A single instructor can teach students regardless of their location.

It is a mature technology with a solid blue chip user base in the West. Unlike other 'new' technologies, BTV is has a proven and accepted place in business and government. Its slow uptake in Asia is not due to reluctance, but because it has been unavailable.

Now is the moment for service providers to begin trying new ways of offering services for this new market. As in other areas of telecommunications, BTV knows no borders. Those who can adapt fastest, form the necessary alliances and market their services will benefit themselves and the region as a whole.

We look forward to the awakening.

Typical Business Television Network Configuration



Clockwise from bottom left...

1. Event begins in a **studio** or **hotel ballroom** equipped with cameras, etc. This is the '**origination site**'.
2. The origination site connects via microwave or land lines to an **'uplink'.**
3. The uplink sends the signal to a **satellite** 35,000 kms above the earth.
4. The signal is re-transmitted to **receive locations** properly equipped at corporate sites or conference centres within the satellite **'footprint'**.
5. At the receive sites, the signal is switched to the rooms cabled for the network.
6. Employees or others watch the event on television sets or video projectors.
7. During Question and Answer sessions, guests can call the originating site on **telephones** in the room to ask questions and make comments.
8. Comments from viewers are sent back out on the satellite to all locations.

New Role of Business Satellite Communications in Japan

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1. ABSTRACT

Today, there is an increasing demand for multimedia information communications systems. This paper discusses the role of satellite communications for business in Japan.

Image processing technology has rapidly progressed, and VSAT technology has produced compact, inexpensive, and efficient satellite communications systems. Consequently, satellite communications systems are expected to become a basic infrastructure element of multimedia information systems, especially in the business sector. Actually, they are now to be promoted in such a way as was previously unforeseen. This paper discusses the role and merits of satellite communications using the distribution retail industry as an example.

2. INTRODUCTION

Satellite communications have so far been used in Japan in very limited areas. News gathering systems for broadcasting and newspaper companies, video distribution for cable TV, and video educational systems for private schools are typical applications. These are one-way and more video-oriented than two-way systems.

In the public sector, about half of the forty-seven local governments have built their own two-way satellite networks for the purpose of anti-disaster systems.

Recently, because of a significant reduction in system costs and the rapid increase in the demand for multimedia applications, satellite communications are playing an increasingly important role in the business communications field.

3. TREND OF SATELLITE COMMUNICATIONS IN JAPAN

3.1 SATELLITE CAPACITY

In Japan, so-called business satellite communications essentially started in 1989, based on the establishment of a new communications service law. In the same year, JCSAT, a private satellite communications business in Japan, launched its first satellite. SCC, another satellite communications business, also launched Superbird A in the same year. Since then, a total of six satellites have been launched to date, and nearly 200 orbiting transponders are currently in operation.

Figure 1 shows the number of satellite transponders launched, and Figure 2 shows their orbital positions.

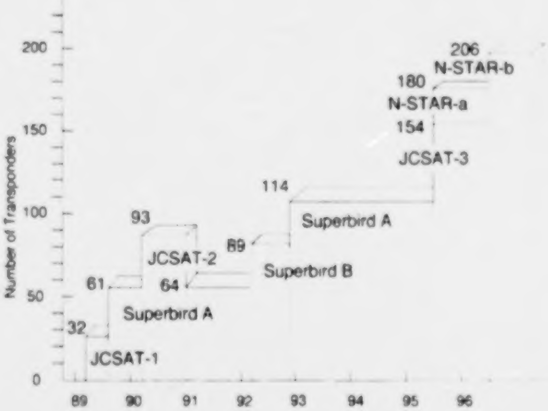

Figure 1 Satellite Transponders Lauched in Japan

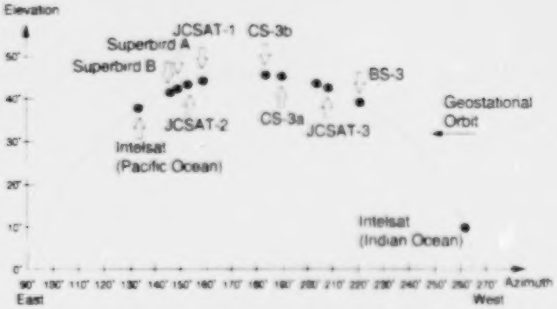

Figure 2 Satellite Position in Orbit

The total capacity of these transponders is equivalent to about 100,000 telephone lines or about 1,000 video lines (MPEG2 class animation).

As new satellites are expected to be launched in the future, the development of application technologies will make satellite communications an important infrastructure in Japan.

3.2 FEATURES OF SATELLITE COMMUNICATIONS

Satellite communications should be exploited for their specific features shown below:

- Wide area communication
- Economical broadcasting
- High-speed accessibility
- Network flexibility

(1) Wide area communication

Satellite communications services can cover wide areas without regard to distance. That is, the same level of service can be provided throughout the country.

(2) Economical broadcasting

Broadcasting is the main feature of satellite communications. Satellite communications are the most economical means for the immediate, high-speed distribution of multimedia information to any location in the country.

(3) Network flexibility

Satellite communications allow communication lines to be easily installed provided that ground station equipment can be constructed. They also allow network nodes to be increased more easily than those in a terrestrial network. In addition, satellite communications are flexible to an increase of data volume; they require no change in ground station equipment, just an increased number of transponders.

(4) Network configuration

Ground station equipment can form various combinations of video, data, and audio signal transmissions depending on the application. Any type of multimedia network based on satellite communications can be constructed as desired.

4. VSAT SYSTEM AND MULTIMEDIA BUSINESS COMMUNICATIONS NETWORK

The integrated use of two-way VSAT systems and one-way multimedia broadcasting systems is effective as the basic infrastructure for satellite multimedia networks.

4.1 TWO-WAY VSAT SYSTEM

An important factor for the acceptance of a satellite communications system is how much economical advantage the system has over the terrestrial network. The expense of satellite communications depends on the ground station equipment cost, transponder cost, and operation performance including network functions. The traditional problem in satellite communications was their higher cost in relation to terrestrial networks.

The VSAT system introduced here solves this problem, both from the aspect of equipment cost and in operational performance, enabling a satellite communications network to be constructed easily and economically.

(1) Transmission media

The following three types of VSAT systems are available:
1) Data transmission system
2) Telephone system
3) Data and telephone hybrid system

The VSAT system can be used for the two-way communication of data, static images, and voice in a satellite communications multimedia network. It can also be combined with a satellite multimedia broadcasting system to form an advanced network.

(2) Features of the system

a. Enables micro-ground stations at less cost

b. High performance VSAT functions
  1) Enables the flexible construction of networks depending on the application and scale. The system supports various protocol interfaces and permits diverse multiple accessing, depending on the traffic characteristics.
  2) Implements LAN-satellite WAN-LAN. The system can connect directly to a LAN.
  3) Implements a highly reliable network that allows for automatic bypass to a terrestrial network.
  4) Offers an economical toll network using a compact DAMA controller.
  5) Centralized monitor and control at the hub station.

The monitor and control unit allows a hub station to perform centralized monitor and control of the entire network, including the local station. It provides an advanced human-computer interface (HCI) for easy operation.

(3) System configuration and functions

The VSAT system consists of a central station called a "hub" and numerous VSAT stations. Figure 3 shows a system configuration.

1) Data transmission system
  a) Data transmission function
     Two-way data transmission can be performed between the hub and VSAT stations. Data transmission can also be performed between VSAT stations via the hub station.
     LAN interfaces as well as serial interfaces of up to 64 kbps are supported for terminal connections.

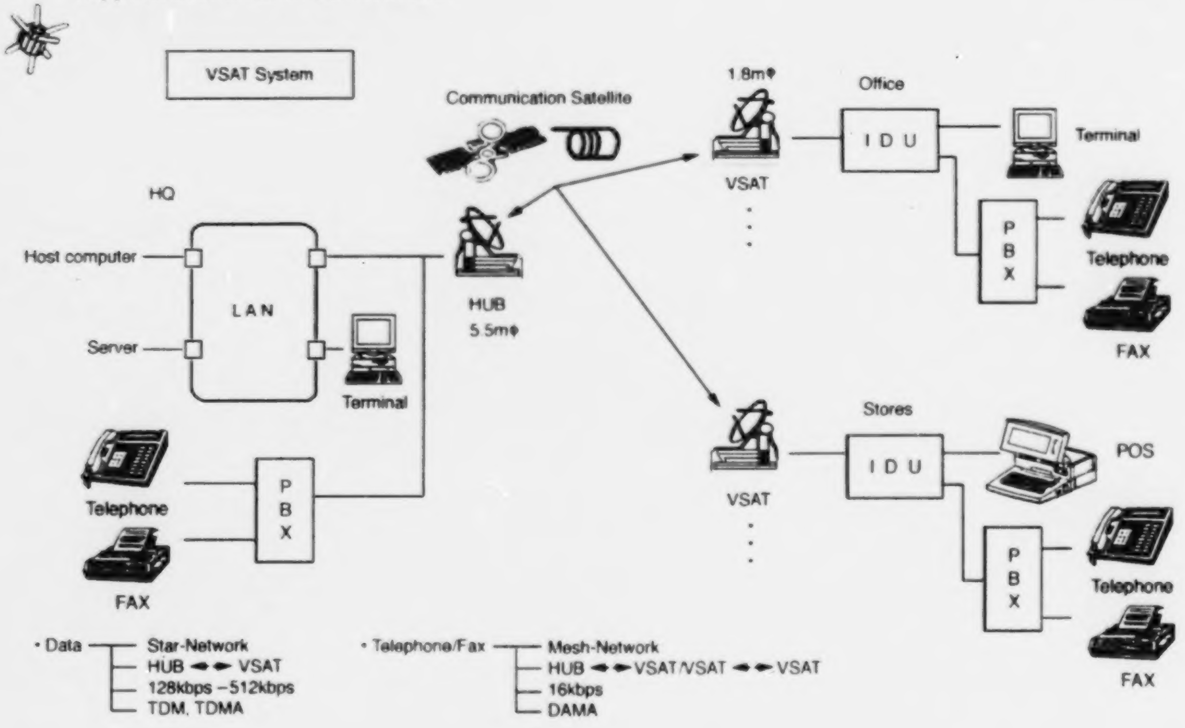
VSAT System
Communication Satellite
1.8mΦ
Office
VSAT
I D U
Terminal
P B X
Telephone
FAX
HQ
Host computer
Server
LAN
Terminal
HUB
5.5mΦ
Telephone
FAX
P B X
Stores
VSAT
I D U
POS
P B X
Telephone
FAX
• Data
Star-Network
HUB ◄► VSAT
128kbps – 512kbps
TDM, TDMA
• Telephone/Fax
Mesh-Network
HUB ◄► VSAT/VSAT ◄► VSAT
16kbps
DAMA

Figure 3 Configuration of VSAT Network

b) Backup function

If the line quality deteriorates due to rain or equipment failure, the line is automatically routed to the terrestrial network (public or INS network).

c) Monitor and control function

The hub station can monitor and control the local station facility and all VSAT stations.

2) Telephone system

a) Telephone and fax transmission function

A mesh type structure allows for speech and G3 fax communication between two locations.

The system supports two digital transmission methods, 16 and 32 kbps, which can be selected by software.

b) DAMA function

The compact DAMA controller enables efficient channel allocation control.

c) Integrated network management function

A centralized management of the network is performed at the hub station.

(4) Economy and serviceability of the VSAT system

Figure 4 shows an economical comparison between a satellite communications system using VSAT and terrestrial networks currently available in Japan. Economical predominance between the satellite and terrestrial networks depends on the number of network nodes and traffic (data or telephone) per node. As shown in Figure 4, the VSAT satellite communications system, as it is used in Japan, is economically superior for networks containing 30 to 50 nodes with medium traffic (two to five lines per node in terms of telephone lines). In correspondence to actual business, this is equivalent to a business with offices distributed throughout the country, each office handling a medium-scale of data and telephone traffic. A business representative of this is chain stores in the distribution industry. Further cost reduction of the VSAT system is expected to promote the use of the system in various industries.

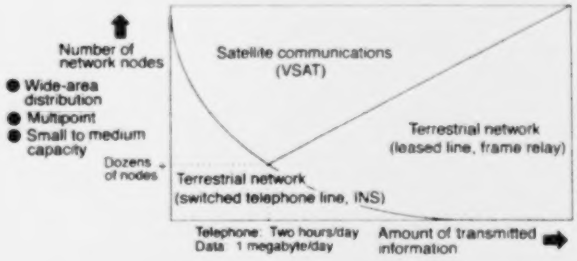

Figure 4 Applicable areas of economical aspects

5. MULTIMEDIA BROADCASTING SYSTEM

Multimedia broadcasting systems are also proving the usefulness of satellite communications. This system uses a micro-antenna and a satellite receiver board, which can be mounted on the expansion bus slot of a PC/AT compatible machine, to construct a synchronous network. It uses a terrestrial network for uplink communication and creates a high-speed intranet. Thus, the system fully utilizes the broadcasting and direct access functions of satellite communications, and is expected to be an important system for multimedia business communications.

5.1 SPECIFIC FEATURES OF SYSTEM

This system has the following specific features:

(1) Uses digital compression video (MPEG1) for effective use of transponders.

(2) Broadcasts multimedia information including image, voice, and data.

(3) Supports private conversations and network management functions for business affairs.

(4) Receives signals using a 45 to 60 cm microantenna and a board mounted in an expansion slot of a personal computer. Receiver costs are low when compared with the cost of the personal computer it resides in.

5.2 SYSTEM CONFIGURATION AND FUNCTION

Figures 5 and 6 each show an entire system configuration using the terrestrial network for uplink communications. The system provides the following functions:

(1) File transmission to terminals

Files are broadcast to mirror sites and remote personal through the satellite network as needed, such as when information in the center server is updated.

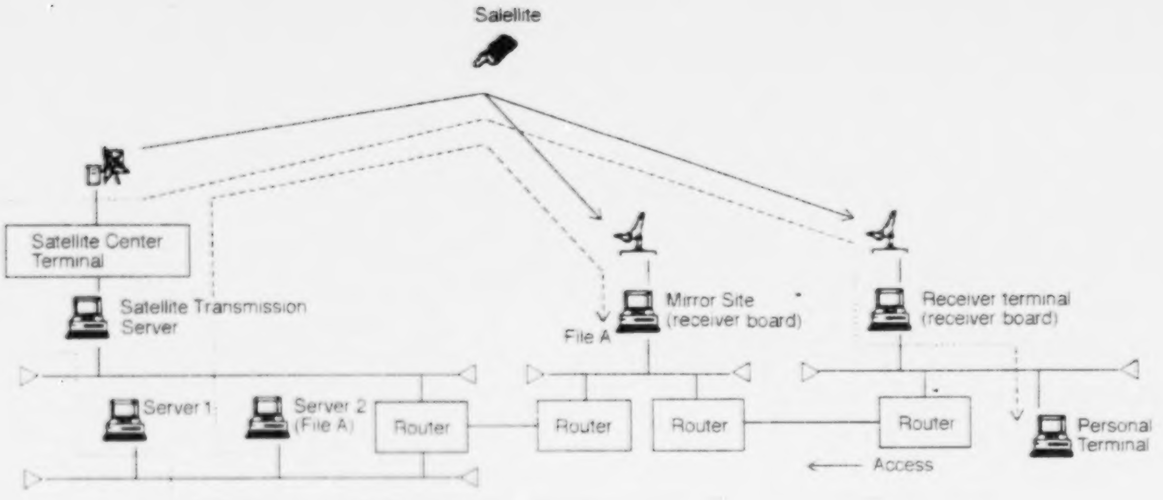
Satellite
Satellite Center Terminal
Satellite Transmission Server
Server 1
Server 2 (File A)
Router
Router
Router
Router
File A
Mirror Site (receiver board)
Receiver terminal (receiver board)
Personal Terminal
Access

Figure 5 Multimedia Broadcasting Network

- Satellite network Video and various database information are broadcast to each receiving station
- Terrestrial network The user operates a personal computer for information retrieval and distribution requests

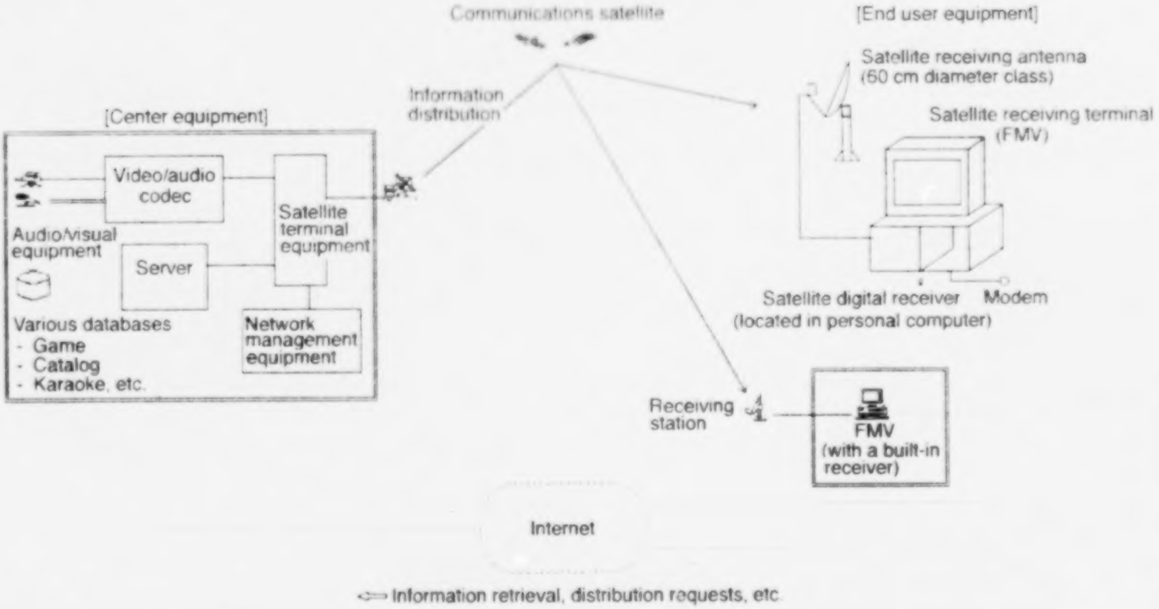
Communications satellite
[End user equipment]
Satellite receiving antenna (60 cm diameter class)
Information distribution
[Center equipment]
Satellite receiving terminal (FMV)
Video/audio codec
Satellite terminal equipment
Audio/visual equipment
Server
Various databases
- Game
- Catalog
- Karaoke, etc.
Network management equipment
Satellite digital receiver (located in personal computer)
Modem
Receiving station
FMV (with a built-in receiver)
Internet
⇐ Information retrieval, distribution requests, etc

Figure 6 Network configuration of multimedia broadcasting system

(2) File transmission by retrieval from the receiving station

1) The receiving station accesses the server via the terrestrial network to retrieve a specific file.

2) The server transfers the specified file to the satellite transmission server.

3) The satellite transmission server promptly converts the received file into satellite network format and sends the file via the satellite network.

4) The receiving station accesses the received file using a WWW browser.

5.3 APPLICATIONS

The multimedia broadcasting system demonstrates its ability with the following applications:

(1) Distribution of product information to stores, individuals, or auctions.

(2) Information retrieval service for people by independent institutions.

(3) Online shopping through personal computers.

(4) Multimedia intranet.

6. JUSCO'S CASE

JUSCO Co., Ltd., a major distributor in Japan, constructed a VSAT satellite network, almost the largest ever constructed by a Japanese enterprise, in the autumn of 1994. The company fully utilizes the network as its basic infrastructure for telephone, data (computer communication), and video. Because JUSCO uses satellite communications for all internal multimedia communications and has greatly reduced their communications costs, they are being watched with keen interest as an unprecedented epoch-making case in Japan.

6.1 OBJECTIVES OF VSAT SYSTEM IMPLEMENTATION

The major objectives of JUSCO's construction of a satellite multimedia network are as follows:

a. Reduction of network cost

As business expanded, the company implemented a LAN in its store system. The selection of economical high-speed lines connecting the LANs was a problem. High in-house telephone and facsimile costs were also problems which called for a low cost solution for the future.

To solve these problems, the company calculated the effect of converting to satellite communications by referring to examples of major supermarket stores in the U.S. They found that satellite communications could reduce costs by about 30% compared with terrestrial networks, such as INS. In addition, satellite communications could quickly manage their communications infrastructure, very attractive to the company, which was spreading their stores mainly in suburban areas.

b. Making business philosophy and top management policies known to all employees.

Satellite communications are an effective means for making top management policies (for example business concepts and policy announcements) known to all employees in offices distributed throughout the country.

c. Enhanced marketing and product management power

Marketing power and product management power are basic factors in retailing. When reconstruction of the communications infrastructure is considered from the viewpoint of enhancing such power, the important points are how to provide customers with accurate information and how to transmit accurate information within the company. These factors motivated the rapid development of a new communications infrastructure that could handle video, static images, voice, and music which were familiar to people.

(1) System configuration

The VSAT system is a star network consisting of a hub station (center station) and VSAT stations scattered around it. JUSCO's system has a 2.4 m diameter VSAT station in each of their six business centers, and a 1.8 m diameter VSAT station in each of their (approximately) 220 stores.

a. Data communications system

A LAN-WAN-LAN configuration is used for data communications. VSAT functions as a remote bridge providing compatibility with multiprotocols.

Because of the importance of data communications, the system has a function that automatically connects it directly to the terrestrial INS network if the quality of the satellite network deteriorates.

b. Telephone system

The telephone system is implemented by a toll network using the DAMA method. Speech is enabled using a number consisting of "station number + existing PBX extension number" between any stations. It supports a teleconferencing function that enables multiparty conferencing over the telephone.

Specific features of the network

Using satellite communications for the backbone network

- Shifting the data/telephone communications of all stores (about 220 nodes) to the satellite network
- Constructing visual communications networks

Satellite multimedia integrated network

- Data: LAN-WAN (satellite)-LAN configuration
  Automatic backup by terrestrial INS network
- Telephone: Satellite toll network using DAMA (line demand-on allocation) method
  Highly efficient audio coding at 16 kbps, narrow occupied band of 30 kHz/ch
- Video: High quality digital video using MPEG method
- BGM: BGM music broadcasting featuring high quality digital sound

Figure 7 JUSCO's Case - Major Functions and Parameters of JUSCO's Satellite Network

c. Digital video and BGM broadcasting system

Digitally-compressed video and voice data can be broadcast from the headquarters to all stores or a specific group of stores.

Figure 7 shows the major functions and specifications of JUSCO's system.

(2) Use of network

JUSCO shifted the entire internal communications network, such as POS data collection/distribution and in-house telephones, to the satellite communications system. The company further plans to utilize the system for multimedia including video and BGM (voice). Figure 8 shows an image of using the satellite communications system in stores. The company uses the system mainly for the following:

a. Providing customers with information using video and BGM

Providing shopping customers with product information using video and BGM is expected to attract customers' interest and increase sales. Also, using video for introducing company activities socially relevant to each region, including opening day festivals, will strengthen the appeal and loyalty in the company.

b. Internal information transmission through visual communications

Using video to transmit business philosophy and company policy directly from top management will increase employee awareness and stimulate their work environments.

A necessary notice of change in sales price can be accurately indicated by adding video information to the product's code and name. When commodities are seasonally replaced or new commodities are entered, use of moving and static images provide timely and accurate reports on commodity trends and sales estimates to stores. Stores can also transmit information such as queries and questionnaires using telephone or facsimile.

A store layout with a display case arrangement is an important technique of the retailer business. The use of video enables the headquarters to easily indicate the methods of displaying and marketing commodities to stores. Pictures of the display cases of specific commodities in stores can be sent as static images to headquarters for checking. These materials also help to construct a database valuable for future store arrangements.

Thus, JUSCO's satellite communications network is expected to keep expanding in both scale and application as a multimedia information processing tool that will reduce communications costs and play an important role in business management.

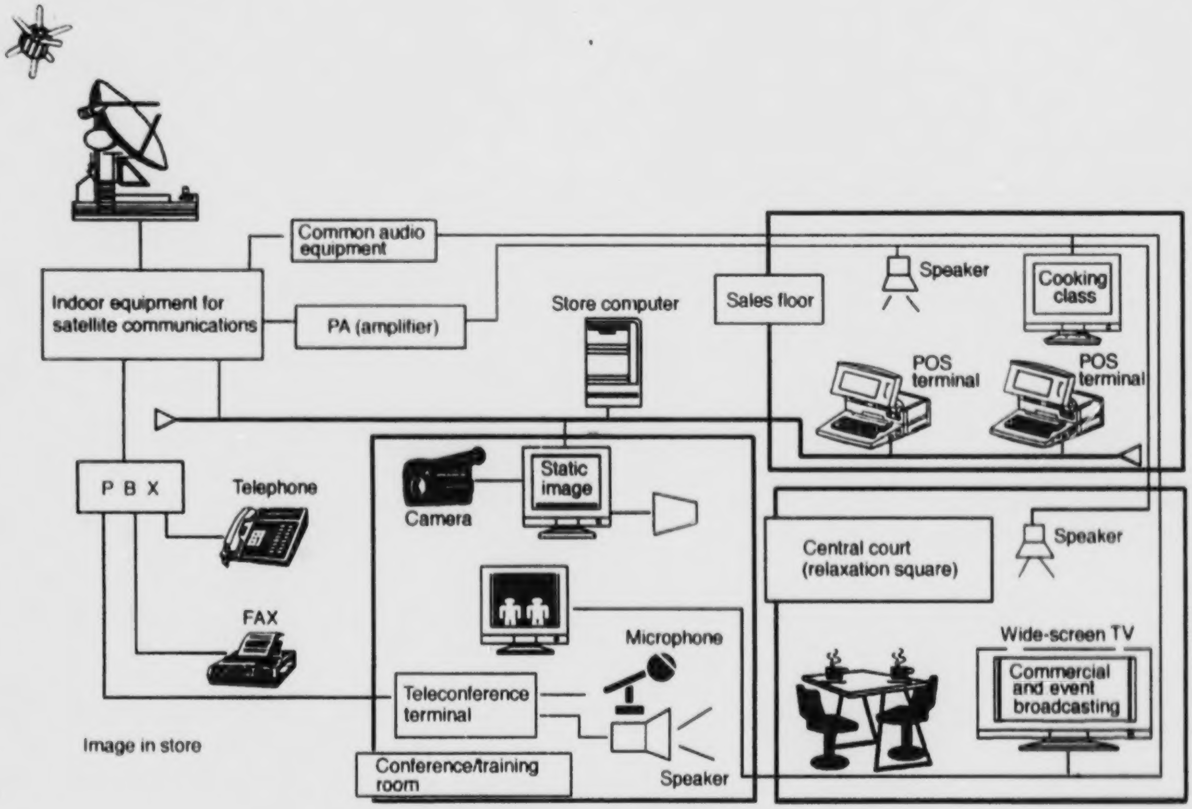
Common audio equipment
Indoor equipment for satellite communications
PA (amplifier)
Store computer
Sales floor
Speaker
Cooking class
POS terminal
POS terminal
P B X
Telephone
FAX
Camera
Static image
Central court (relaxation square)
Speaker
Microphone
Wide-screen TV
Commercial and event broadcasting
Teleconference terminal
Image in store
Conference/training room
Speaker

Figure 8 Applications of JUSCO's Satellite Network

7. Conclusion

This paper has discussed two satellite communications systems supporting multimedia networks.

The "satellite multimedia broadcasting system" is a one-way communications system used for multimedia information which includes video, audio, and data. It is implemented by compact receiving antennas and the effective use of transponders. The "VSAT system" is a two-way system for data and telephone communications. It enables the construction of advanced economical networks.

Satellite communications in Japan will increasingly be used for two-way multimedia communications of telephone and data as well as video, and are expected to play an important role as a full-scale multimedia infrastructure in business.

A Fully Automated Directory Assistance Service that Accommodates Degenerated Keyword Input Via Telephones

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1. ABSTRACT

We have developed a fully automated telephone directory assistance system that utilizes intelligent interactive information retrieval technologies. Without any operator assistance, customers can access this service directly through conventional touch-tone telephones. The system provides users with a stress-free keyword input interface which guides them with recorded speech generated by filling slot-type sentence templates with proper terms. This system is especially characterized by a newly developed input interface that reduces user input workload and time to almost half compared with the conventional coded letter input methods.

2. INTRODUCTION

Directory assistance (DA) service at Nippon Telegraph and Telephone Corporation (NTT) has a long one-hundred-year history. In 1981, the DA service experienced some significant changes, a computerized DA service was introduced, and over the following 15 years improvements in both functions and performance have been implemented. This service, named ANGEL, was available only via telephones in its first decade of use. Although we regularly have about 2.6 million calls daily, totaling approximately 800 million calls per year, NTT has been suffering from a big deficit due to the fact that this service is charged at a strategically low cost, too low to cover all of the expense including personnel expenditures and operations cost for the system. Still thousands of human operators must be employed to operate the 24-hour service for the over 6,000 computer terminals that are necessary to keep ANGEL operating.

To improve these conditions, we developed alternative DA services available on computer terminals, which were set in operation in 1992. These included personal computers and notebook-type terminals specially designed for DA services. Software on these terminals is either pre-installed or delivered free to users on floppy disks. Recent internet technology has made it possible to download the software through the NTT home page. Connections from personal digital assistance (PDA) terminals were also included in recent years. In spite of these efforts, these new services have not met with great success or acceptability by the users. Only one percent of daily calls are served through terminals by self operation.

A fully automated DA system was developed to provide users with a more convenient system to access DA service and to augment the automated services, which in turn would contribute to decreasing the deficit.

3. ANALYSIS OF CONVENTIONAL SERVICES

Some of the main reasons why users do not use conventional automated services are analyzed in this section:

(1) When users require assistance from a DA service, they often cannot find a terminal near-by which has the DA software and a modem.

(2) Telephone calls are much more convenient in obtaining this service than any other choices. A user must have patience to wait for the modem connection, in comparison to dialing only a few digits and establishing a connection with as human operator.

(3) Most Japanese users are not very familiar with keyboard operations. This characteristic is common among those who are middle aged. They do not like to sit and operate keyboards. Talking with human operators and informing them of keywords for information retrieval is much more convenient and enjoyable than performing key operations.

This last point seems to be a serious issue even if we provide good software with an excellent GUI running on good computer terminals.

To cope with these problems and to improve the above deficit situation, we tried to develop a fully automated DA system. The new system should meet the following conditions in order to be accepted by a wide range of users from teen-agers to the elderly.

(1) Terminals should be conventional telephones. Users can easily find these terminals and dial up to connect with a DA center. There are fifty times more telephones than computers terminals in Japan.

(2) The entire service process should be fully automated and computerized. NTT must provide users with a new and convenient keyword input method because speech recognition technologies are still underdeveloped for introduction to this kind of practical system which will be used by a variety of people. Dialog processes should be properly controlled by an intelligent interaction system. As for the output, each dialog message should be conveyed to users through recorded speech, synthesized voices, or some combination of these.

(3) Only twelve keys can be used for input operations. Thus, user keyword input operations should be drastically improved as far as the human interface aspect, such as the look and feel, the operation time, and convenience.

(4) The number of keywords obtained from users should be minimized so that users can quickly obtain the correct result. Users often become tired with long, boring dialogs with computers.

This paper proposes methods for solving the above problems and to show how to achieve a fully automated DA system. We have already developed a prototype system to meet these conditions which is currently running on client-server (C/S) workstations connected by FDDI local area networks. By calling this system through conventional telephones, users can converse with a computerized operator and by providing the necessary information to the operator through the touch-tone keys, a target phone number can be obtained.

We will elaborate on the details in achieving this system, system configuration, system performance and the evaluation of the system performance.

4. KEYWORD INPUT METHOD

The issue of the keyword input method requires serious thought because this method plays an integral part of our system with respect to convenience.

4.1 PROBLEMS FROM KEYBOARD INPUT

The keywords required by a DA service are an address and the subscriber's name, such as a personal name (given and family name), a company name, a shop name or an organization name. In countries where English letters are used in spelling, these keywords can be spelled out by 27 character keys. In Japan, no practical method can be prepared because there are more than two thousands Kanji characters in use in addition to 71 hiragana characters. To input Japanese words, a method is used that converts a word into its phonetic spelling and expresses the word in hiragana characters. An existing computer keyboard which has alphabetical keys, ten numeric keys, and some other additional character keys is sufficient to accommodate these hiragana characters.

One self-operation-type DA service which is already available via modem connection is designed to use a special note-type terminal called ANGEL-NOTE which has a keyboard with hiragana keys and other control keys configured in a 5 x 14 matrix. These terminals were once delivered free to users to increase self-operation among users and decrease the deficit incurred by human-assisted services. This trial was not successful because users could not become accustomed to the irregularly allocated hiragana keyboards. Users also did not want to keep an additional terminal besides their telephones merely to use these DA services for a few calls a month.

4.2 CONVENTIONAL INPUT METHODS

Other methods have been proposed which use the 12 numeric key pad to input Japanese words from existing telephones, mobile telephones, pagers, or handheld electronic notes. Some of these methods are introduced here.

Before proceeding, the following is the default Japanese letter allocation to twelve touch-tone keys, including alphabet allocation based on ITU recommendations (1).

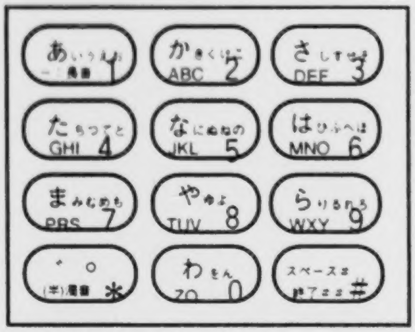

Fig. 4.1 Default Allocation of Hiragana and Alphabetical Charactors to Mobile Phones

As is shown in Fig. 4.1, five Japanese characters are basically allocated to each button key just as on alphanumerically marked telephones. Letters allocated to button key "1" are vowels. Each of the other five letter groups includes relatives which have the same consonant and different vowels. Letter groups which have consonants of g, z, d, b, and p are commonly input by entering an additional notation "゛" to the original letter indicating that these letters are related to the original letters having consonants of k, s, t, h, and h, respectively. Table 4.1 shows these relationships and their combinations.

(1) Letter cycling method

This input method was most commonly used in mobile and wireless telephones. Users utilize this method to store their personal phone numbers with names and/or addresses for quick reference.

Table 4.1 Hiragana Allocation to Touch-Tone Keys

Key	Assigned letters
1	あいうえお (A, I, U, E, O), and Yes.
2	かきくけこ (KA, KI, KU, K, KO) and ABC.
3	さしすせそ (SA, SI(shi), SU, SE, SO) and DEF.
4	たちつてと (TA, TI(chi), TU(tsu), TE, TO) and GHI.
5	なにぬねの (NA, NI, NU, NE, NO), and JKL.
6	はひふへほ (HA, HI, HU(fu), HE, HO), and MNO.
7	まみむめも (MA, MI, MU, ME, MO), and PRS.
8	やゆよ(YA, YU, YO), and TUV.
9	らりるれろ (RA, RI, RU, RE, RO), and WXY.
0	わをん (WA, WO, N),Q,Z, and No.
*	Used as an additional notation for the following Japanese letters to show (゛) or (゜). がぎぐげご (GA, GI, GU, GE, GO), ざじずぜぞ (ZA, ZI, ZU, ZE, ZO), だぢづでど (DA, DI, DU, DE, DO), ばびぶべぼ (BA, BI, BU, BE, BO), ぱぴぷぺぽ (PA, PI, PU, PE, PO). Used as a control key.Single touch (#) means
#	"space" or "comma".Double touches (##) means " Input termination".

In this method, the first letter is displayed when pressed after changing the mode to letter input. Letters are cycled to the next one by pressing a button one time and come back again to the first one after each five clicks. If we want to obtain the letter "と(to)", we need to choose button 4, the consonant "t" and press it five times to arrive at the vowel "o".

(2) Coded letter method

This method has become very popular among teenagers who have pagers and want to send messages to their friends. Seventy one Japanese letters, alphabetical characters, numbers, and some other control signals are all coded by two digit codes derived from the twelve touch-tone signals. For example, the letter "あ(a)" is coded by "11" and a letter "い(i)" by "12", "う(u)" by "13", and thus "と(to)" by "45". Using this method, users can easily make any message expressed in hiragana characters, though this process will require some time to construct a full-length message.

(3) Coded word method

This input method is entirely independent of letter allocation methods described in the letter cycling method or a coded letter method. This is often used in telephone shopping or ticket reservation service over the telephone. This method employs a special digit number given to each word and merchandise, flights, trains, and so on. Users always need to carry a code book to use this kind of service.

When considering the available terminals and the user environment, the coded word method is the least efficient because it is dependent on users carry coding books for addresses and names covering the whole country.

Secondly, the letter cycling method is also not user-friendly because it is difficult to ensure that the correct sequence of buttons is pressed to obtain the correct letter sequence. Also, there is no way to send an address or a name to the computer center as a string of characters instead of touch-tone signals.

Thirdly, the coded letter method seems to be more practical than the two other methods only if users do not mind keeping all of the coded digits for letters in mind or keeping a reference sheet If users are required to use the letter cycling method or coded letter method, users will most likely experience frustration in attempting to correctly enter information to inform a DA system of keywords.

The common problem in these input methods is that the possibility for errors in the information input process will increase and will cause system errors in finding a correct answer for the user requests.

4.3 PROPOSED INPUT METHOD

Taking these issues into consideration, we have developed a more convenient input method with less stress than the above methods. Although this method can be used only when a user or a system retrieves a database to find a target record to meet the user requests, this method is expected to decrease the number of key strokes and drastically improve the human-machine interaction.

The new input method proposed in this paper is called a degenerated input method. The input process is very simple. By simply pressing a button key which includes the desired letter, a letter can be input. There is no need to select which of the five letters is input into the system. For example, when the desired input is "とうきょう(to-u-ki-yo-u) =TOKYO", we just press the button sequence "41281", according to its phonetic spelling. English letters can be also entered in the same way according its spelling, for example "588" to enter "NTT".

Compared to key sequences such as "45(to)-13(u)-22(ki)-83(yo)-13(u)" using the letter coded method or a key sequence such as "44444(to)-111(u)-22(ki)-888(yo)-111(u)" using the letter cycling method, it is clear that this new method is much more convenient and stress-free.

An experimental comparison is shown in Table 4.2 in terms of the average number of key strokes and the time required for inputting one letter. Even based solely on this table, the ease and convenience of the proposed method are made readily apparent.

Table 4.2 Comparison of Input Methods

	Method	Touches/ Letter	Input Time/ Letter (seconds)
1	Letter Cycling	2.6	1.9
2	Coded Letter	2.0	2.2
3	Degenerated (proposed method)	1.1	1.3

At the same time, consideration must be given to the fact that this method may suffer from a potential problem. Since this method allows users to neglect vowel information in the inputting process to lighten the input workload, the possibility of inaccuracies still remains. If the input digit length is N, the possible combinations of letters will be 5 to the Nth power (5**N). Identifying these combinations is a considerable task.

A similar idea was discussed in the case of English words with the same input method(2). We can simulate the same idea because this DA environment will also handle a set of words in a closed set such as addresses or subscriber names. The major difference is that the diversity of words in our proposed application is much wider than the few words used in the referenced paper. There is of course, the concern that our study may progress into ambiguities that cannot be resolved in a short time, because there may be many alternatives corresponding to a given sequence of numbers. The entropy value calculated for the set of addresses and subscriber names used in this study will provide clues to solving this problem.

4.4 ENTROPY CALCULATION

To make entering keywords with degenerated input useful, it is important to decrease the workload for the system and users while they cooperate in attempting to identify a target city or town name and subscriber's name stored in a huge database. The workload necessitated in this process can be estimated by measuring the entropy of the environment we must handle. Although many studies have been done concerning the entropy which a certain language has(3)(4), evaluating the entropy of a small environment consisting of diversified groups of words such as addresses or personal names has not yet been done. We found that evaluating the address or name information measured in terms of entropy will reveal if this system can accommodate a degenerated input method. The results are shown in Table 4.3.

Table 4.3 Entropies for Addresses and Personal Names

	Number of Occurences	Hiragana Expression (bits)	Numerical Expression (bits)	Entropy decrease (bits)
Prefecture Level	47	5.55	5.20	0.30
City Level	3722	11.87	11.76	0.11
Town/Block level	371221	18.10	17.94	0.16
Personal Names	157377	12.76	11.15	1.61

This result indicates that information lost by coding addresses or names into 11 numerical numbers from 71 hiragana letters is very small in the cases pertaining to addresses, however, information loss in the case of personal name case is somewhat larger. This shows the fact that the word space does not significantly degenerate even if compressed into a smaller space such as in expressing words using numerical codes. Thus, identification of unique phonetic spellings in both an address and a name is actually not as difficult as first presented by simple combination calculations.

5. DIALOG CONTROL

5.1 BASIC DIRECTIONS

Our basic idea for controlling the user-operator dialog is based on the requirements for minimizing the user input. Thus, this system is designed to start by prompting the user to input a city name, because the prefecture can be easily identified from the city name. Then, it prompts for the target person's family and given names or a company name accompanied by its job classification as minimum inputs. In case users do not have or cannot recall these inputs, the system will prompt users as to whether they have related keywords to select candidates in order to obtain the correct subscriber. The prompting of additional keywords will be iterated until the target is identified.

The possible problems caused degenerated inputs require still more keywords to resolve the ambiguities in such a manner so as not to inform the users that the system has such problems. Keywords should be selected from among the related information that users often take for granted. This control is essential to show users the system's proficiency and to maintain user's confidence in the usability of the system.

5.2 DIALOG EXAMPLES

A typical dialog example showing how degenerative inputs cause ambiguities in the retrieval process is illustrated in Fig. 5.1. Note that yes/no questions, represented by "1" and "0", are frequently used to avoid tedious user input of full length words.

The computerized operator prompts the user in a synthesized voice and instructs the user through the decision part of this system. The interaction part reads out a recorded guidance from a database directed by the decision part. Since this guidance is basically a slot-type speech, it will be filled with proper addresses or names (5)(6). All pieces of addresses and most of the names are recorded and are found in a prerecorded voice database. If an input is not found, the interaction part has a software voice synthesizer, developed in another NTT laboratory, to prompt for another response.

After obtaining the user inputs, the decision part sends the information to a proper database for analysis. If ambiguities caused by a degeneration as shown in Fig. 5.1, the inputs have several possibilities for the same phonetic spelling, the decision part prompts the user for more related keywords to resolve the ambiguities. Figure 5.1 shows such a case using a detailed town name in an

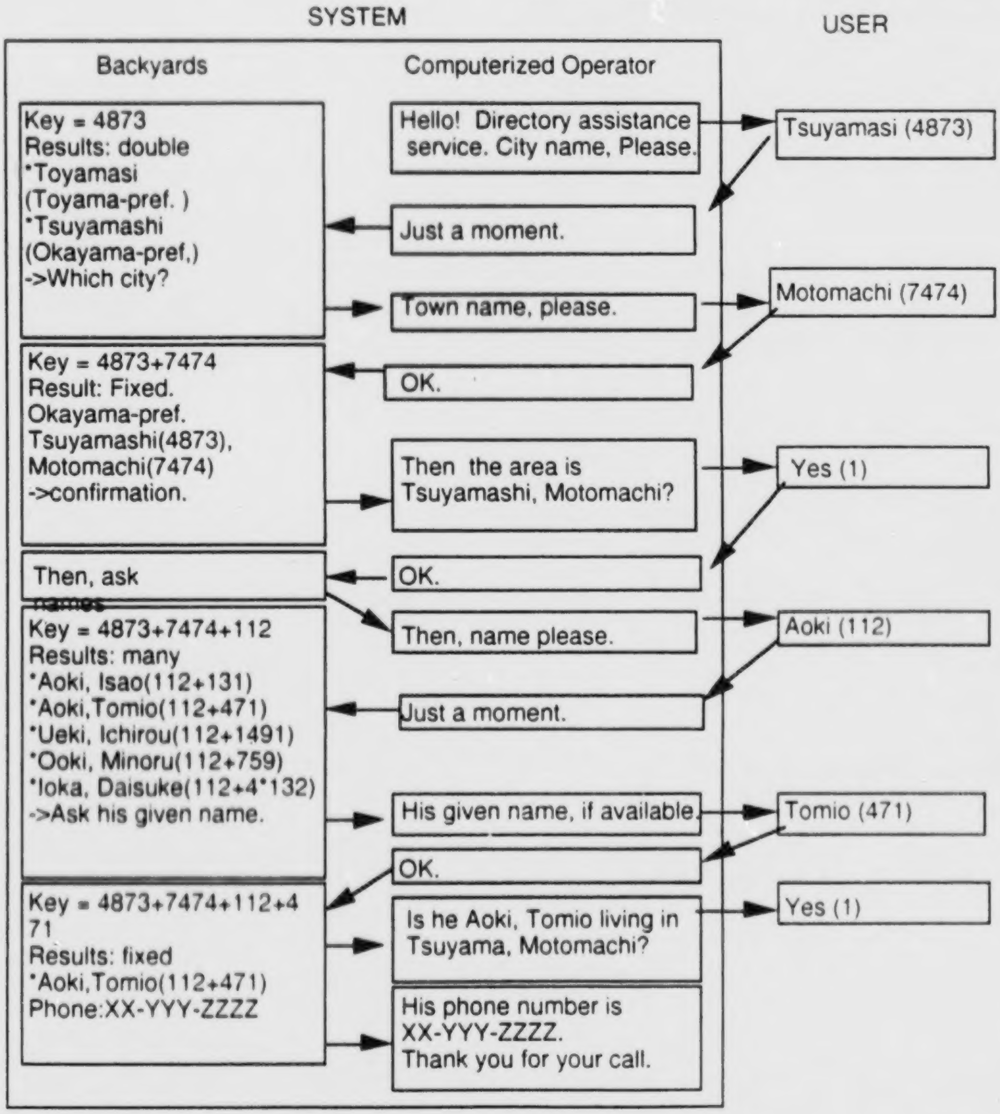
SYSTEM
USER
Backyards
Computerized Operator
Key = 4873
Results: double
*Toyamasi
(Toyama-pref.)
*Tsuyamashi
(Okayama-pref,)
->Which city?
Hello! Directory assistance service. City name, Please.
Tsuyamasi (4873)
Just a moment.
Town name, please.
Motomachi (7474)
Key = 4873+7474
Result: Fixed.
Okayama-pref.
Tsuyamashi(4873),
Motomachi(7474)
->confirmation.
OK.
Then the area is Tsuyamashi, Motomachi?
Yes (1)
Then, ask names
OK.
Then, name please.
Aoki (112)
Key = 4873+7474+112
Results: many
*Aoki, Isao(112+131)
*Aoki,Tomio(112+471)
*Ueki, Ichirou(112+1491)
*Ooki, Minoru(112+759)
*Ioka, Daisuke(112+4*132)
->Ask his given name.
Just a moment.
His given name, if available.
Tomio (471)
OK.
Key = 4873+7474+112+471
Results: fixed
*Aoki,Tomio(112+471)
Phone:XX-YYY-ZZZZ
Is he Aoki, Tomio living in Tsuyama, Motomachi?
Yes (1)
His phone number is XX-YYY-ZZZZ.
Thank you for your call.

Fig. 5.1 An Example of Operator-User Dialog.

address and a given name. As is shown in the figure, an interaction process progresses with good cooperation between the user and the computerized operator.

6. SYSTEM DESIGN

6.1 BASIC REQUIREMENTS

A unit prototype of this system is designed to handle up to about 400 simultaneous calls. Since human-operator assisted service has been very familiar to users for more than 10 years, it is not certain whether this fully automated service will be accepted by those users. We thus decided to start from a small-size system. A scalable system configuration with the capability to quickly increase to meet any rapid increase in the number of users. The following two main factors were considered in our system design.

Down-sizing is a key factor of this new system design. Recent advances in computer technologies have made it possible to achieve a highly reliable on-line real-time system with workstations. Our limited obligation for this system, i.e., initially covering a small portion of the total DA calls, encouraged us to introduce workstations into this system. Approximately 700-1,000 lines must be connected to this system to handle about 10% of the daily calls, assuming a call can be completed within two or three minutes.

Economics was the other factor in consideration. Recent market competition in performance and price of workstations and disk memories has enabled us to configure a unit system at a lower cost than anticipated. Off-the-shelf network control units were purchased to control up to 23 calls though a single 1.5-Mbps ISDN line. These factors were great driving forces in achieving this service at a greatly reduced cost compared to the previously custom-made systems.

6.2 SYSTEM CONFIGURATION

Our basic idea comprises a unit system with a set of client/server workstations connected to a 100-Mbit FDDI local area network as illustrated in Fig. 6.1.

(1) Server workstations

One high performance workstation assumes the role of a server containing the subscriber database, the indices, and the recorded voice database used for interaction with users. This workstation retrieves the requested information from a client and returns it to the client via FDDI. The size of subscriber database is about 25 GB for 64 million subscribers, and that of the indices is also about 20 GB to achieve quick reference. The recorded voice database includes about a thousand guidance, about 200 thousand address fragments covering all of Japan, about 200 thousand name fragments comprising Japanese personal names, and about 80 thousand fragments which makes up a variety of company or shop names. The size of the database installed in a server is about 100 GB in total.

(2) Client workstation

The other workstations assume the role of clients which control all user aspects in the system. User calls are handled with off-the-shelf network control broad units inserted into an EISA bus. This board will answer user calls, receive touch-tone signals from

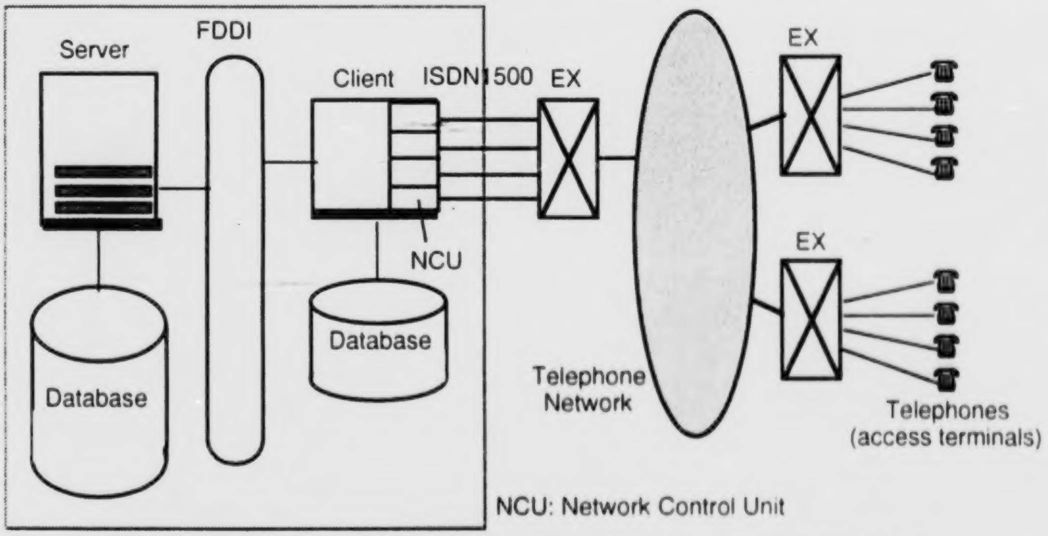

Fig. 6.1 System Configuration of an Automated Directory Assistance Service

the user, edit them, send them to a server, receive a response from the server, send it to the user, and terminate the user call when finished. Up to 23 calls can be simultaneously controlled with a board and additional boards can be inserted to the bus to meet the traffic increase up to 92 lines per client. As four clients can be connected to a FDDI, up to 368 lines can be handled by a unit configuration.

7. EVALUATION

After completing the first prototype, we asked some monitors to use this system and to fill out a questionnaire. We evaluated this system from the following two points of view.

7.1 PERFORMANCE

Table 7.1 shows the average performance for four different cases evaluating DA service for personal subscribers.

Table 7.1 Performance Evaluation

Cases	Keywords Conditions (Keywords obtained from users)	Accuracy (%)	Connection Time (seconds)
1	(City name+Town name) & (Family Name + Given Name)	99.0	62
2	(City name) & (Family Name + Given Name)	85.0	71
3	(City name+Town name) & (Family Name)	65.9	99
4	(City name) & (Family Name)	16.5	120-180

(1) Accuracy

The accuracy is defined as the ratio of calls that could return correct target phone numbers after a proper dialog with a user. This is heavily dependent on the keywords a user prepares before a call or can recall in the dialog with this system. This shows that if a user has the correct city and town name and the target subscriber name (both given and family names), this system can almost perfectly obtain the phone number. In case users fail to provide some information, the accuracy decreases depending on the importance of the information. For example, when a user only knows the city name and a family name of the target, it will be nearly impossible to obtain the correct number from this system.

(2) Service Time

The time required to complete the dialog also heavily depends on the keyword conditions. The reason why the time in Case 2 is shorter than that of Case 3 is that the full name of the target subscriber is more important than the town name. It will take longer if users only know the family name, except in such cases that the occurrence of that name is very rare in a specified city area. For commercial purposes, the system should finish the search within approximately 3 minutes.

7.2 HUMAN-USER INTERFACE

Judging from the questionnaires, the user interface seemed to be effective. The look and feel of the newly proposed input method was much more acceptable to users than expected. Simplicity in entering keywords provided users with a comfortable and easy way to access the DA service. We are certain that the initial anticipated anxiety experienced by the users was alleviated to the point where the computerized operators could obtain enough information to resolve the ambiguities in a short dialog.

Accuracy values for shop or company information retrieval were approximately 78% if full knowledge and the memory of the users are utilized. The time is almost the same for personal subscriber retrieval. These cases show higher accuracy values than the requirements from business sectors.

In the near future, we plan to investigate and evaluate the response time when more than 400 calls rush to this system at the same time. Although almost all the problems concerning functions and performance have been solved, still further investigation is needed into updating changed records, the number of which runs into hundred thousands a day. This will be a key issue if this service is to be provided to the public.

8. CONCLUSION

We have developed an operator-free, fully automated DA system. This service is scheduled to be introduced into commercial service by the NTT department responsible for the DA service. The only hurdle to be cleared is to establish a method to update the user database quickly while maintaining up-to-date correspondence with the information stored in a mother database created and maintained by a customer care system.

This system, which accommodates degenerated keyword input backed by intelligent interaction with users, can be extended to handle other business transaction services through conventional telephones. Application examples are in banking, ticket purchasing, and other services of voice-based information providers.

The basic idea used in this system is language-independent. If the entropy decrease due to degeneration is small compared to that of the user environment of the original words in a given language, a similar service to the proposed can be implemented in the same manner in other countries.

9. ACKNOWLEDGMENT

We wish to express our deep appreciation to Mr. Yasuo Sakama, Mr. Sei-ichi Ido, and Mr. Naoshi Nakamura for their kind support throughout the development of this system and to Mr. Jin-ichi Murakami and our project staff for their fruitful discussion and comments on the content and style of this paper.

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EISA : Extended Industry Standard Architecture
FDDI : Fiber Distributed Digital Interface

PT. TELEKOMUNIKASI INDONESIA: TOWARD BROADBAND INFRASTRUCTURE AND REACHING THE NATIONAL PROMINENCE

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1. ABSTRACT

TELKOM (the nick name of PT. TELEKOMUNIKASI INDONESIA) has moved rapidly to modernize its network into broadband capability. In line with the improvement of network, TELKOM also has state thet multimedia will be a core business. This paper will basically browse into the strategy of TELKOM toward broadband networks and services.

2. TELECOMMUNICATIONS TREND AND THE GLOBAL CHANGES

Currently, telecommunications is one of the fastest growing aspect in globalisation which will greatly impact to the growth of economic development. In 1994, The Los Angeles Time reported that telecommunications has taken the most important role in any sector of economy, and even more strategic than the role in oil and steel industry. Andersen Consultant report estimated that the global value in telecommunications by the year of 2000 will reach the amount of US$ 1100 billion with the estimated revenue of US$ 600 billion per-year.

The technological advances wich has been developing over the past several years will have taken root in the global market place by 2000. In China 60.000 km of SDH fiber optic trunk lines will in place by 2000. India has smaller but still significant plans to built the SDH system in a number of routes over 1995-1997. Japan is currently extending fiber to the homes, business and institutions of the nations wich will be completed by the year 2006.

Todays conventional voice network have never been ideally suited for the non voice traffic they carry. Non voice applications, such as interconnecting LANs or transferring files between data centres, require large amount of bandwidth often for short periods of time. Voice networks used for many of these applications are optimized to deliver relatively small amounts of bandwidth for relatively long periods of time. As an alternative, have deployed separated packet data networks to provide bandwidth on demand. Still, in its traditional form, this technology has limited capabilities for very speed applications.

To overcome these networking deficiences, a solution to integration and access to virtual unlimited bandwidth is being developed in the form of revolutionary new technology known as B-ISDN. B-ISDN employs switching techniques that are independent of physical transmission speeds, allowing the network to expand its capacity as need without major equipment overhauls. Broadband is designed to meet the users requirement for high speed switching and multimedia (voice, data, video) support over a common backbone network.

Although some elements of B-ISDN technology are currently being deployed, it will be many years before services become universally available. In the interim, other technologies, such as MAN and

SMDS, will provide many of the same capabilities today through minor modifications to existing networks. These technologies can also provide an evolutionary path to broadband networks of the future.

The development of new high speed networks and multimedia communications protocol has permitted implementation of most of the communications services of multimedia systems. The use of those kind of networks and multimedia protocols which is implemented in such applications as telecommuting, teleconference, electronic education and electronic shopping will change many way of everyday life style in the community.

A new knowledge-based world order will develop, where the home, the school, the office and the whole world community will be tied together within an intelligent communication services, presenting possibilities for unprecedented scientific development, economic development growth and educational development, along with many other advances, which will combine to accelerate the evolution of human's cultural development.

3. TELKOM'S EXISTING NETWORKS AND SERVICES

3.1 CURRENT SITUATION

Indonesia has just completed its long term 25 year development project. It is commencing its second long term development plan starting with five year term plan abbreviated REPELITA VI.

Economic developments strategy and selected sectoral development plans of REPELITA VI strongly indicate that the Indonesian economy will increasingly rely on the telecommunications infrastructure to sustain high economic growth and to improve living standard.

Until today, TELKOM, a pubilc company, has been the single instrument for the government to promoting the development of telecommunications facilities for domestic market. Under TELKOM's development management, the number of telephone lines has been doubled sence five years ago. New services has been introduced and the qualities of traditional telephone services have been greatly improved. The penetration ratio has been equal to 1.79 in 1996, although is still in the lower part of the Asia Pacific average, but is revealing a national challenge for the improvement.

So far, the participation of private sector in telecommunications has been exist by providing the telephone service in a specific small area under revenue sharing basis agreement with TELKOM. The cellular telephone service providers, on the other hand, work on a regional basis cooperation agreement with TELKOM. Some small-size companies providing non basic services also pay their role in the Indonesian telecommunication sector. In fact, the Indonesian government liberalizes value-added services.

3.2 TELECOMMUNICATION POLICY OF INDONESIA: UNDERGOING RAPID CHANGE

Indonesian government has decreed the construction of five million new telephone lines in REPELITA VI. The total project will amount up to seven billion dollars. It is quite a heavy burden if TELKOM has to build such a huge capacity of telephone lines by itself.

Government has been designing several scheme to encourage the private sector to participate in constructing the telecommunication infrastructure. In parallel with this progress, another significant policy development is a more liberalized approach to market structure.

Since the establishment of TELKOM in 1991, the telecommunications market deregulation has been rolling steadily.

The Indonesia's telecommunication policy development tells that the entry condition to the editional operators depends on specific services, such as, trunking services, cellular services, etc. However in the co-operation scheme, as far as the operation and construction are concerned, the private sector participation begin to be widely opened. From five million new telephone lines, about two million of them will be build and operated by private sector under joint operation scheme basis with TELKOM. We believe that

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government will go further in restructuring the market.

3.3 EXISTING NETWORKS AND SERVICES FROM BROADBAND POINT OF VIEW

TELKOM has moved rapidly to modernize its telephone network by installing optical fibre trunk and digital exchanges. Nearly 60 % of the national network became digital in 1993 with a full digitalization of the network expected to be completed by 2005.

Since 1993, TELKOM has introduced the telecommunication management network (TMN) system, a new layer in telecommunication infrastructure which is responsible for efficiently and effectively managing telecommunication network nodes from centralized and integrated location.

Upgrading of the transmission switching functions in the network has also allowed TELKOM to position its operation to flexibly take advantage of new telecommunication technologies. For exemple, TELKOM has launched the ISDN service in 1995, introduced Signalling System 7, and prepared SDH implementation in anticipation of future customer requirements for new services. Some of the most promising N-ISDN applications for commercial customers include remote data communications and transfer, group 4 fax and wide band services will also provide customers with familliar services and higher grade of quality.

The capability of network was followed by implementing the Metropolitan Area Network based on IEEE 802.6 DQDB (Distributed Queue Dual Bus) standard offering SMDS (Switched Multimegabit Data Service) which was started mid of 1996 as a first step toward the development of broadband ISDN in Indonesia.

4. TOWARD BROADBAND NETWORKS AND SERVICES

4.1 TELKOM'S NEXT GENERATION NETWORKS

TELKOM will improve its network with broadband capabilities toward B-ISDN. To realize this program, TELKOM has developed the stepping stone of new technology implementation toward B-ISDN as depicted in Fig.1.

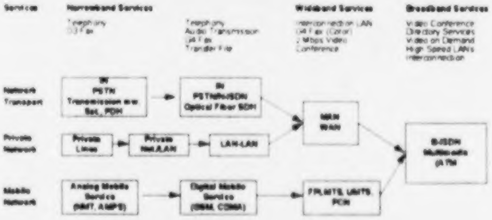
Services
Narrowband Services
Telephony
G3 Fax
Telephony
Audio Transmission
G4 Fax
Transfer File
Wideband Services
Interconnection LAN
G4 Fax (Color)
2 Mbps Video
Conference
Broadband Services
Video Conference
Directory Services
Video on Demand
High Speed LANs
Interconnection
Network Transport
PSTN
Optical Fiber SDH
MAN
WAN
Private Network
Private Lines
LAN-LAN
B-ISDN
Multimedia
(ATM)
Mobile Network
Analog Mobile Service (NMT, AMPS)
Digital Mobile Service (GSM, CDMA)
FPLMTS, UMTS, PCN

Figure 1. The stepping stone of new technology implementation toward B-ISDN

4.2 TELKOM'S NEXT GENERATION SERVICES

In line with the improvement of network, TELKOM has state that multimedia will be a core business. The implementation of selected multimedia services is depend on the market and the availability of network.

Video conferencing

Being a country with more than 13000 islands, distance is still a main problem. Taking that fact, it would be appropriate if we chose video conferencing as our gateway to the multimedia world. Video conferencing may be divided on 2 big categories: studio-based video conferencing and desktop video conferencing (Desktop VC).

First category fits for big conference which involves a lot of people. The trade off is the price of equipment required. Desktop video conferencing is much cheaper because only regular 486 or Pentium PC required. The PC shall be equipped with video card, sound card, microphone and mini camera in order to run the video conferencing software.

Desktop video conferencing may varies in type of line connection. Desktop VC with ISDN connection is the most popular at the moment, but it only supports one party and one connection at a time. It also requires the subscription of ISDN line. Desktop VC with LAN connection is on the

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way to be the king in video conferencing products. The unique feature of such products is the ability to take advantage existing computer, cabling and LAN connection. It also supports the usage of one line to be shared by everybody connected to the LAN. In short, Desktop VC running on top of LAN has very clear market opportunity.

Looking from TELKOM's point of view, this trend should be handled by providing reliable line for LAN-to-LAN connection. Because regular X.25 connection is limited to 128 Kbps, then more sophisticated approach such as Frame Relay, SMDS or ATM is urgently required.

In anticipating those more sophisticated approach, TELKOM will place switched Video Conferencing services on trial for internal TELKOM use through video switched network by using several I1 line interconnection. This trial will placed by the end of this year in Jakarta and Bandung.

Directory Services

Directory services are also subject to be popular in Indonesia. Companies such as Elnusa Yellow Pages are eager to sell their data via network. Fact that HTTP is getting more popular, there should be a provider who could act as directory servers for other companies. The servers would keep the companies profile, product information and other important information which the companies would like to provide. This information then would be accessible from all over the world via the Internet.

Looking from TELKOM's point of view, this is a very big market to involve with. All TELKOM has to do is get connected to Internet and set one or two mini computers acting as servers. Current TELKOM's connection to Internet via IPTEKNET shall not be used to sell commercial materials, so new direct connection to the Internet is a must.

Video On Demand

While two above applications are designated for business customers, Video on Demand (VoD) is designated for residential customers. Most recent VoD software could run on a 486 PC. This helps customers to keep their current investment while adding new services on top of that. It is possible running VoD on top of existing leased line, but in that scenario there is nothing that TELKOM do. TELKOM could play a role in providing VoD services by providing switched VoD services utilizing ATM switches.

In anticipating this service that could be provided to customers, TELKOM will placed switched Video On Demand services on trial for internal TELKOM use through video switched network by the end of this year in Jakarta and Bandung.

High Speed LANs Interconnection

This is a very near future big and still growing market for TELKOM. While the private sector still offers LANs Interconnection utilizing low cost X.25 technology, opportunity to sell more advanced technologies such as Frame Relay or SMDS is still wide open. Those two mentioned technologies have their own trade offs. Frame Relay is suitable for private networks interconnection, while SMDS is better for public network implementation.

5. THE USAGE OF BROADBAND INFRASTRUCTURE AND AN APPROACH TO REACHING THE NATIONAL PROMINENCE

As the commitment to upgrade the network into broadband capability in a nationwide coverage, TELKOM should also anticipate the success usage of the services in an efficient and effective way for the customers in accordance with the national commitment to set up the NII which will accelerate the growth of economic development.

The various segment in Indonesia economy, such as manufacturing industry, banking and financial institution, hotel and tourism industry, healthcare service and trading company will take advantages through better use of broadband infrastructure in term of IT (Information Technology).

The accent of TELKOM's strategy has so far evolved through:

- The collaboration and co-operation with other institutions that have some experiences and capabilities in computer networking and applications. This scheme will accelerate in transforming the beneficial usage of the new advance broadband services to the customers.

- Emphasis in promoting the usage of the new advance services in a small scale trial to the proper customer in a proper sector and application as an initial stage.
- Build some live demos applications in some sectors which have been ready to form the connection in a nation wide coverage.

6. CONCLUSION

Due to the very fast development of both network and service technologies it is wise to always follow the evolution of technologies. Standardization takes place mostly in International Telecommunication Union, which TELKOM has been member for a long time, while ATM technology is being developed by ATM Forum.

TELKOM has already been trying to define what steps to take in order to join the broadband community. One such step is the implementation of Metropolitan Area Network (MAN) offering Switched Multimegabit Data Services (SMDS). Still, there should be advantages in observing other countries activities on preparing their broadband networks and services.

As the commitment to upgrade the network into broadband capability in a nationwide coverage, TELKOM should also anticipate the success usage of the services in an efficient and effective way for the customers in accordance with national commitment to set up the NII which will accelerate the growth of economic development.

7. REFERENCES

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- TELKOM's Grand Scenario of Telecommunication Technology 1994 (GST'94)

SATELLITE MULTIMEDIA INFORMATION DISTRIBUTION SYSTEMS AND APPLICATIONS

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ABSTRACT

Interactive CS multimedia information system is studied. This system utilizes existing infrastructure, that is CS, IRD for DBS, public telephone line, and Internet in addition to DBS TV programs to aim at cost-effectiveness. It is shown that in one channel of MPEG-2, text, graphics, still picture and sound can be transmitted to a great number of subscribers at very high transmission . The transmission cost is remarkably low compared with alternative services. Typical applications such as shopping, education, entetainment,and business are studied. Finally, the social impact is addressed.

1.INTRODUCTION

Recently in many places in the U.S., interactive TV services using cable or optical fiber, mainly for VOD(Video On Demand)services, have been on trial along with announcements of commercial service in the near future. However, these plans have been delayed by at least few years.One of the reasons is that these services are not profitable in the short term.This means the system involves high cost in the development of new infrastructure and equipment. On the other hand DBS(Direct Broadcast Satellite) services are now available, and some market projection of integrated receivers and decoders (IRD) for DBS in US is 3.7 millions (cumulative figures) in 1996.

PC on line services are now becoming popular and according to the spread of Internet, the popularity will be accelerated. But PC on line services have two bottle necks to spread in many applications, that is transmission cost and speed. We studied the multimedia interactive communication satellite information system, utilizing the existing infrastructure, that is, CS(Communication Satellite) , public telephone line, Internet, and IRD for DBS. We present cost-effectiveness study of this system which enables virtual shopping malls or other life and business supports in addition to DBS TV programs.

2. SYSTEM ARCHITECTURE

System architecture is shown in FIG 1. This system supports multimedia information(text, graphics, still picture, and sound) transmission by using almost exclusively existing infrastructure. We call this interactive multimedia information system as MLISS(Multimedia Living Information Shower from Space). This leads to lessen the cost for constructing the system. IRD for DBS can receive radio wave from CS and tune to a channel of TV programs from a broadcasting station. Or it can receive the above mentioned multimedia information from a MLISS center and descramble, decode and display it on a TV monitor. The IRD is connected to a public telephone line through a modem usually to charge for pay per view programs. The IRD can be also connected to a public telephone line or the Internet trough a PC. The subscriber requests information which is selected in menu GUI(Graphic User Interface) on a TVset.The requests include receiver ID, or sometimes a secret key of requested information to MLISS center through a public telephone line for on-demand packet mode (P mode) which will be discussed later. MLISS center searches the requested information in a server, transmits the result to a broadcasting station where it is multiplexed with TV program, modulated in PSK(Phase Shift Keying) and transmitted to the CS. This public telephone line may be connected to Internet. To transmit requested data, this system uses CS which has faster transmission speed than that of a public telephone line or the Internet. MLISS has another service mode which transmits the same information cyclically to every subscribers. We call this B (Broadcasting) mode which will be discussed later.

3. COMMUNICATION SATELLITE

The MPEG-2 Systems international standard (ISO/IEC 13818-3) defines the TS(Transport Stream) which is being widely adopted in video transmission application fields,especially in DBS services in conjunction with the MPEG-2 Audio and Video compression standards.We decided to use the MPEG-2 TS in MLISS due to the fact that it allows private data,and also because of its easy handling and low cost LSIs.

3.1 Transmission efficiency

(1) The efficiency of FEC rate

When FEC rate is 3/4, the efficiency is 75%.

(2)The efficiency of TS packet

Header length is 4 Byte in packet length 188 Byte. The efficiency is

$$(188-4)/188=97.5\%$$

(3) The efficiency of queuing

It is assumed that the transmission speed of this system is 6 Mbps including FEC bits which equals roughly 1 channel of MPEG -2 video. Assumption for the traffic model of this system are: typical queuing model of Poisson distribution as input probability, constant holding time, and number of output lines equal to one.New arriving packets are queued behind packets already in the buffer if any. From the buffer, TS packets go out first-in first-out at the rate of 6 Mbps. The average packet queuing time W is

$$W=\frac{ah}{2(1-a)}. \qquad \text{(Eq.1)}$$

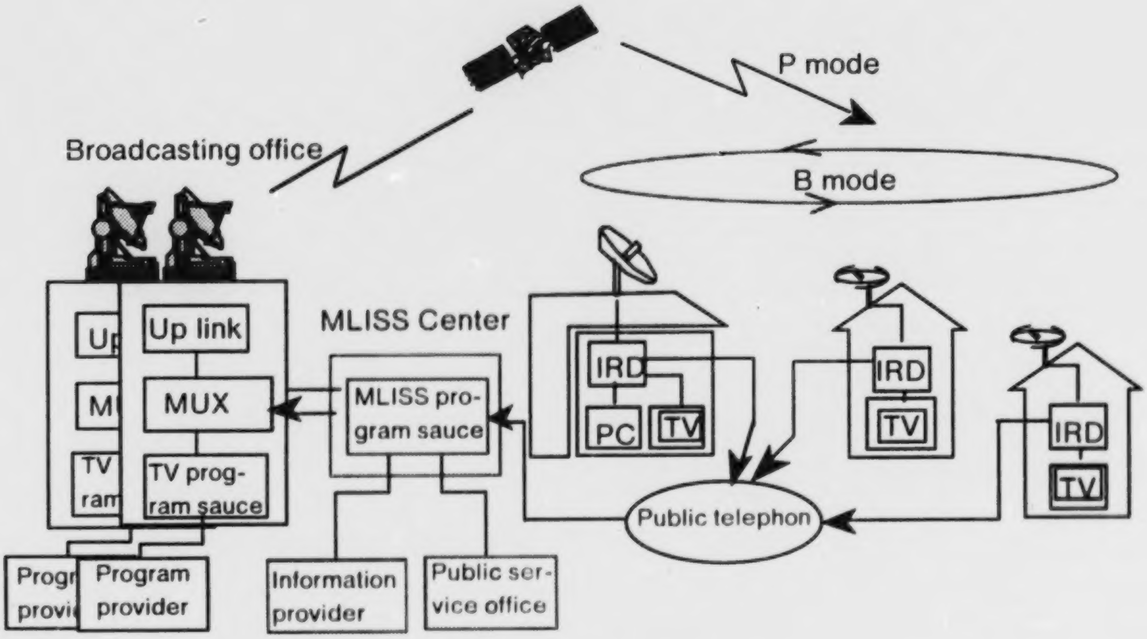
P mode
Broadcasting office
B mode
Up link
MUX
TV prog-
ram sauce
MLISS Center
MLISS pro-
gram sauce
IRD
PC
TV
IRD
TV
IRD
TV
Public telephon
Program
provider
Information
provider
Public ser-
vice office

FIG.1 MULTIMEDIA LIVING INFORMATION SHOWER FROM SPACE

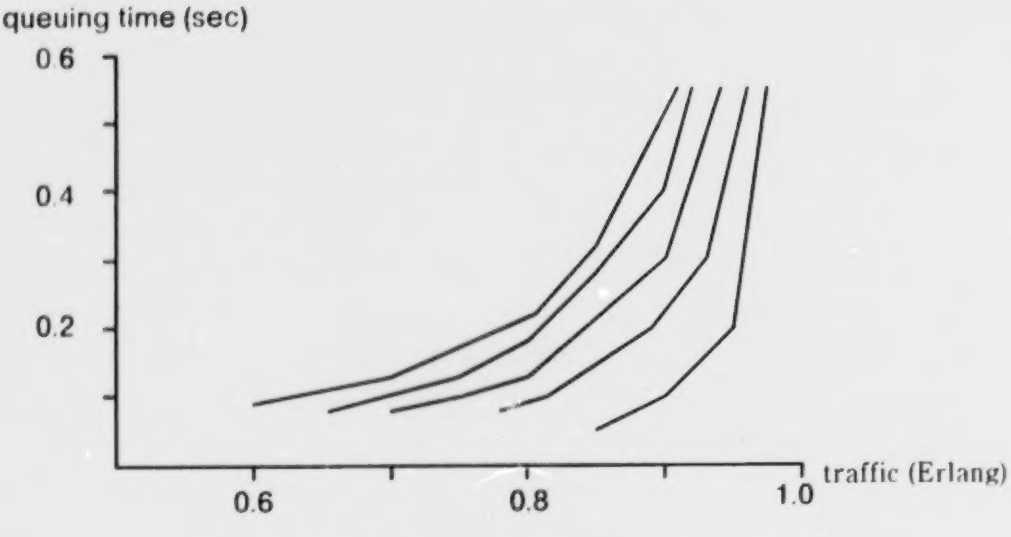

FIG.2 TRAFFIC AND QUEUING TIME

and then,

$$a = \frac{1}{1+h/2W}. \qquad \text{(Eq.2)}$$

Where h is average holding time, and a is traffic in Erlang. From Eq.2, the channel capacity for 0.3 second average queuing time is calculated. Average data quantity 100~500kbit cases including header and FEC are calculated and shown in FIG. 2.As a typical example, we consider, compressed data of still picture of 400kbit, graphics data of 160 kbit, text data of 1kB=8kbit, and we take 189kbit as the average of the above figures. Sound data for explanations is about 0.6 kbps (text-to-speech synthesis technique is applied here and this is mentioned later) and average sound data is 12 kbit which is equal to 20 seconds explanation.Finally, the average multimedia data quantity per picture becomes about 200 kbit and 274 kbit including FEC and header.According to the FIG 2, if the packet queuing time of 0.3 second is permissible, the transmission efficiency of queuing becomes 92.9 %.

(4) Total efficiency and time of transmission

Total transmission efficiency becomes 69%. Transmission time including radio wave turn around time of 0.26 s and average queuing time of 0.3 s is added.

274 kbit/6 Mbps +0.26+0.3=0.61 s

This transmission time is quite fast.

3.3 Example of subscriber capacity and transmission cost

Subscriber capacity per 6 Mbps can be estimated as follows. Assuming an average size of 200 kbit per picture and total transmission efficiency 69 %, 20 pictures per sec can be transmitted in 6 Mbps. In our shopping application, it is assumed that one person views 30 pictures in 30 min. on an average a day and 10 % of the traffic concentrates in the busiest one hour.Therefore,

20 pictures x3600 s/(30 pictures x0.1)=24,000

That is, subscriber capacity is about 24 thousands per 6 Mbps.In this example, if the rental cost of CS transponder is 600 million yen a year mostly for transmission cost, the cost per day per subscriber is 14 yen under the condition that one transponder contains five 6 Mbps channels.

Cost per picture becomes 0.5 yen on average and which is quite cost-effective. TABLE 1 shows MLISS transmission cost and transmission speed compared with terrestrial public communication networks.

4. IRD

IRDs for DBS can be utilized for the MLISS system only if RAM for application software is added. The basic block diagram of the IRD for DBS is shown in FIG 3. Radio waves from the communication satellite are received by a small(about 40 cm diameter) antenna, the TUNER tunes to a particular transponder, the signal is then QPSK demodulated and error-corrected in FEC which gives a transport stream containing 4 or 5 MPEG2 programs. The stream is demultiplexed to a MPEG2 program in TRANSPORT. A program is decoded to video,

	MLISS(6Mbps)	ISDN(64kbps) (local)	MODEM(28.8Kbps) (local)
Cost (yen)	0.5	10 (1)	10 (1)
Time (sec)	0.6	3.1(2)	6.9 (2)

(1) minimum access charge
(2) a few seconds dialing time should be added

TABLE 1 COST AND TIME TO TRANSMIT 200Kbit

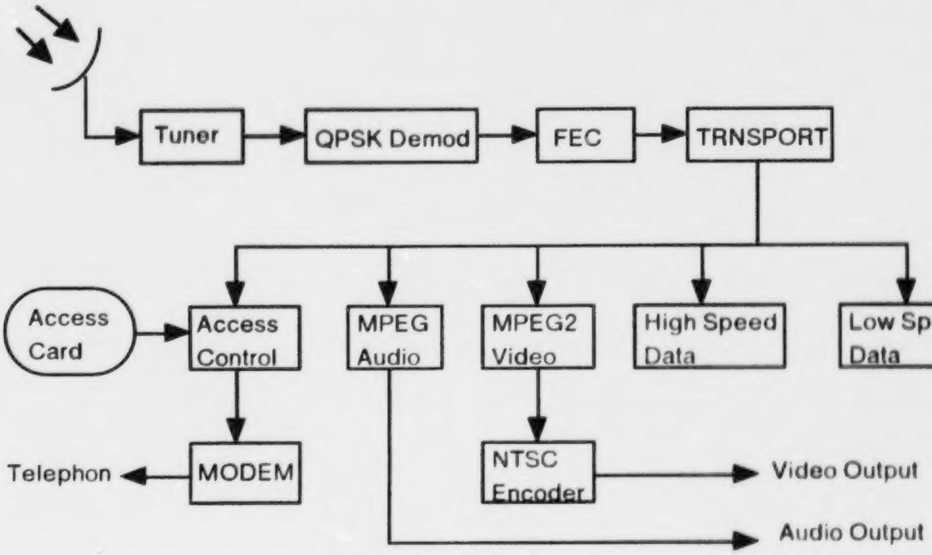
Tuner
QPSK Demod
FEC
TRNSPORT
Access Card
Access Control
MPEG Audio
MPEG2 Video
High Speed Data
Low Speed Data
Telephon
MODEM
NTSC Encoder
Video Output
Audio Output

FIG 3 BASIC IRD FOR DBS

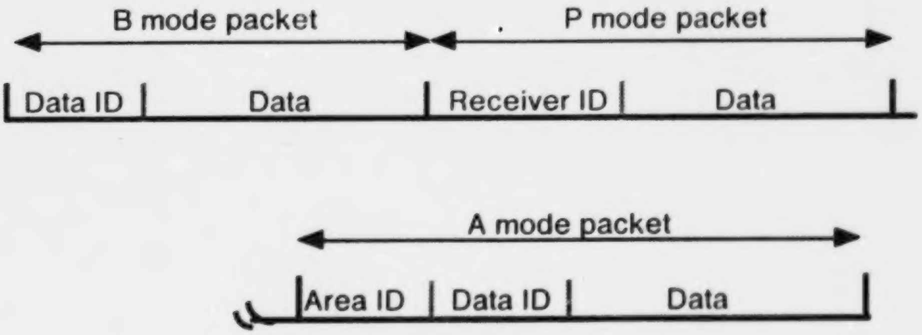
B mode packet
P mode packet
Data ID
Data
Receiver ID
Data
A mode packet
Area ID
Data ID
Data

FIG. 4 3 DIFFERENT PACKET MODE

audio and data in MPEG2 Video, MPEG Audio, High Speed Data, Low Speed Data, respectively.

4.1 Down loading of application software

MLISS deals with shopping, karaoke, games, etc. at home in P mode and B mode between a MLISS center and homes.In order to support various kinds of applications, down loading of application software is necessary. For this purpose the IRD needs additional RAM. If IRDs had sufficient RAM,they could be used in this system without any significant modification. The increase in cost would be less than 1 thousand yen from the basic IRD for DBS.

4.2 Still picture decoding

The IRD for DBS decodes still picture by using MPEG-2 video intra-flames. Picture quality is as good as NTSC.

4.3 Sound transmission

Sound transmission is important because voice indication or guidance are easy to understand. Indication or guidance on a display requires concentration and search by eyes.

High quality sound transmission requires large data quantities especially for music.This system fundamentally uses text-to-speech synthesis method, that is, IRD receives text data and synthesize it to speech. By this method sound bit rate can be compressed up to about 0.6 kbps. When some application requires music , IRD may have CD-ROM driver and select the appointed music by transmitting the code corresponding to the music.

5. SERVICES

MLISS uses 3 different types of data packets. This is shown in FIG.4. In B mode all subscribers can access the data when they know the data ID beforehand. This mode is like changing channels in analogue broadcasting TV. In P mode(on-demand mode), the packet header contains the receiver ID ,so that P mode packet can be accessed only by the subscriber whose receiver ID matches that in the header. In A mode (area specific mode) packet header contains area ID and data ID. IRDs are categorized in areas and the only IRDs whose area ID matches that of the packet header can access the data. FIG.5 shows the transmission flow of P mode packets. MLISS will cover millions of subscribers. The length of a PID, which is a program identifier defined in the MPEG-2 Systems standard, is 13 bits.Since only 8,000 subscribers can be covered,receiver IDs are reused. The MLISS center distributes a receiver ID to a subscriber who wish to use P mode. After the requests are completed, the ID has to be returned to the MLISS center.

MLISS will be applicable for the following services,

1) offering multi-lingual living information
2) shopping and EC(Electronic Commerce) including foreign trade
3) education and training
4) entertainment
5) accessing to data base including Internet

Some services are described below.

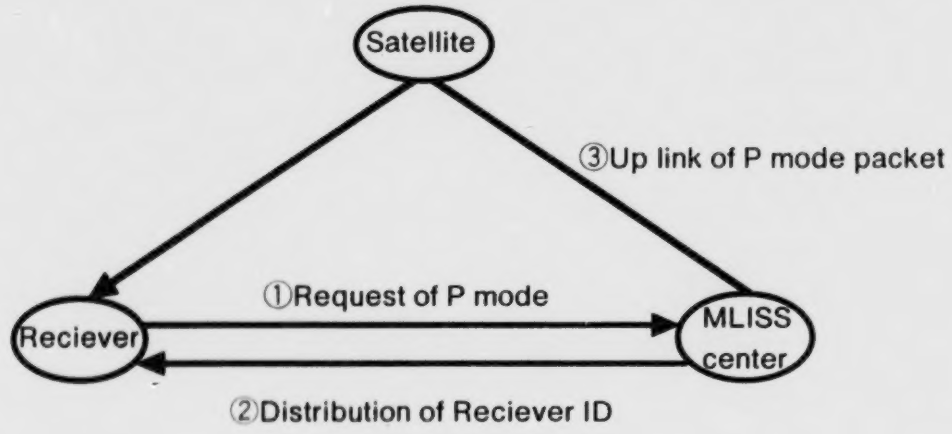
Satellite
③Up link of P mode packet
①Request of P mode
Reciever
MLISS center
②Distribution of Reciever ID

FIG.5 SEQUENCE OF P MODE PACKET

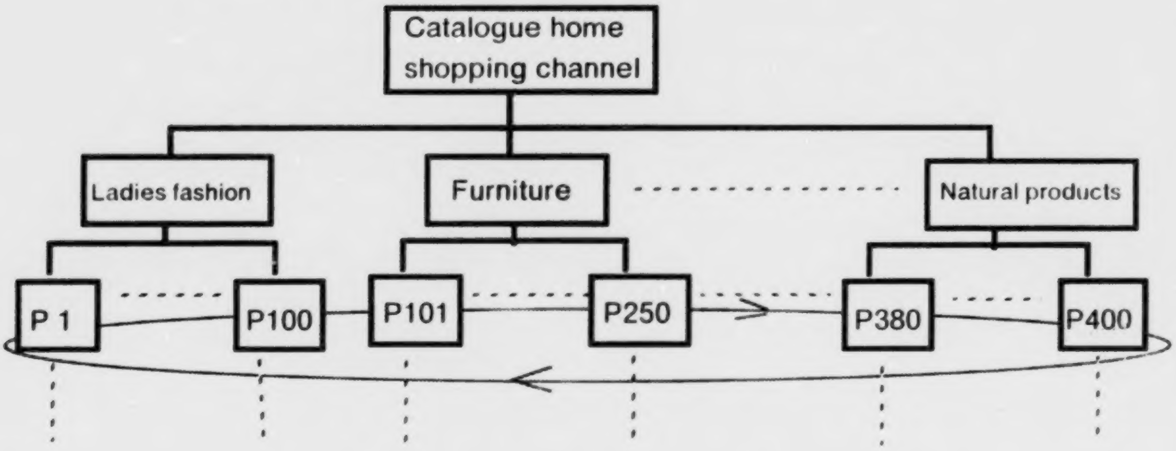
Catalogue home shopping channel
Ladies fashion
Furniture
Natural products
P 1
P100
P101
P250
P380
P400

FIG.6 B MODE IN CATALOGUE HOME SHOPPING CHANNEL

5.1 Interactive home shopping services and EC

MLISS will be applied to catalog-based home shopping which will be an interactive service. FIG.6 shows a sample interactive home shopping channel which uses B mode. Each page of catalog is transmitted cyclically. For a 400 page catalog with 6 Mbps bit rates and 300kb per page, the cycle time is about 20 seconds.Due to the fact that two adjacent pages are loaded in IRD ,the next or the previous page can be accessed instantly.In this case, every subscriber can access up-to-date catalog just like turning over pages. When the subscriber wants to access private data such as private price,P mode is used.

We show the comparison of transmission cost between paper catalog and MLISS. In paper catalog,assuming cost for printing,paper,and mailing as 500 yen, twice publishing per year, and publishing volumes 2 million, the total cost is 2 billion yen. In contrast with the cost for MLISS using 6Mbps capacity is 100 million yen and it is 1/20 of the paper catalog.

MLISS can support booking services. In B mode, a magazine which includes shopping, events, or tour information is transmitted. In these services,proper payment accountability is supported.MLISS can either use the method in DBS for pay-per-view which is based in smart (IC) card or EC methods being developed now.

The system for home shopping services is expandable to business services such as cyber or virtual company including foreign trade. As an example, a MLISS center can store home pages of companies updated by telephone data links. The electronic commerce and intra-net functions are also provided by the MLISS center. Thus, even small companies are fully supported by MLISS in domestic and international business activities.

5.2 Home and small school education services

Many needs in this area can be identified.In Japan, the majority of children commute to supplemental schools at night. Many students go to preparatory schools for entrance examination to universities. Less equipped small schools in rural area all over the world have insufficient teacher staffing problem. Small businesses have needs for employee education and training. MLISS can provide the following services for these needs.

(1) Text and image only

A CAI(Computer Aided Instruction) system can give less expensive interactive individual education to homes, small schools and businesses. The transmission cost is 0.5 yen per 200 kbit page.

(2) Voice

In this service,a teacher speaks to a group of students using texts and images.

The voice signal of one hour class contains

$$64\,kb / s \times 3600s = 230\,Mbit\,.$$

The cost is $0.5 \times 230 / 0.2 = 575$ yen.

The voice quality is same as AM radio.

(3)Motion video

The motion video shown on a window of a students display will need around 1.5 Mb/s. One hour class costs

$$575 \times 1500 / 64 \cong 13500 \text{ yen.}$$

Thus,low cost remote education can be realized for small number of students without video, and for bigger number students with video.

5.3 Interactive network karaoke services

The present network karaoke system is fundamentally storage type and only new music in MIDI(musical instrument digital interface)format is transmitted on the network after midnight to take advantage of low fares.

In contrast,MLISS can transform this system to a fully interactive network karaoke service.Typical data amount of a network karaoke is about 150 kbyte. (1)

The cost involved is

$$0.5yen \times 150kbyte \times 8/200kbit = 3yen$$

The characteristics of low cost and fast speed of MLISS as shown TABLE1 can eliminate storage device from the present system .This will allow the use of MLISS karaoke system at home in addition to business locations. The title list menu is transmitted in B mode,while the subscriber requests are in P mode.

5.4 On-demand game sharing services

Game sharing service is another data broadcasting service. The subscriber checks the program guide for desired game software beforehand and sends the request for downloading. In the MLISS on-demand game sharing service, subscribers check the game title menu transmitted in B mode.Requests for game software are sent in P mode to the MLISS center.Requests can be sent at any desired time.

6. EFFECTS TO THE SOCIETY

Recent worldwide trends show that with free open borders around the globe, multinational societies are increasing. Providing customized support to everyone, e.g. multi-lingual information, will be an important challenge for our system.The use of our interactive system in shopping applications will be geography independent (shopping around the country), cost-effective for both users and service providers, and fast. Therefore this interactive system will lead to drastic cost reduction and vast increase of trade. Especially in Japan, living cost is more expensive than many other countries. MLISS can improve some inefficient domestic and foreign trade mechanics.MLISS can also support disaster prevention and remote medical check.

In business field, this interactive system will easily realize work at home and satellite offices and it can also contribute to the improvement of the commuting conditions in some Asia-Pacific countries.One of the main features of this system is that it can accelerate the transmission speeds for Internet access. Application fields for Internet and Intranet now under consideration will increase considerably in the near future.In Japan multi-channel CATV is not popular as in the U.S. But, MLISS could become a popular service getting similar market share figures. In this case it will create a great impact in various areas to the society.

References

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Worldwide Satellite PCS Technology—
An MSS Perspective

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The vision of personal communications services (PCS)—as portable, handheld devices that "go anywhere"—is rapidly becoming a reality. Satellite-delivered PCS is ideal due to its truly global reach, but the promise of MSS technologies is in danger of being delayed by the regulatory and business problems inherent in spectrum allocation.

1. *Satellite-based Personal Communications Services (PCS)*

The ultimate vision for personal communications services (PCS) is wireless communicators that can go "anywhere." This vision for communications services has been around for many years. Dick Tracy's wrist watch telephone illustrates this vision. With this small and inexpensive go-anywhere communicator, people can be reached by voice or data with a single phone number—no matter where they are. No more separate numbers for office, home, pager, facsimile, or car. No more being out of touch on a mountain hiking trip, or on a city street.

Now this vision is solidifying in the rapid deployment of cellular and PCS in many cities around the world. In the United States, cellular companies are signing up more than 28,000 new customers each day. In the recent PCS spectrum auction, the Federal Communications Commission collected US$7.3 billion in license fee. In the Asia-Pacific region and in the CIS area, the urgent need for telecom-munications services is resulting in the rapid installation of cellular and satellite-based VSAT equipment. In China, the total number of cellular subscribers already exceeded 3 millions in 1995 and is expected to double every four years.

The FCC has defined PCS as "a family of mobile or portable radio communications services which could provide services to individuals and businesses and integrated with a variety of competing networks. . . . . The primary focus of PCS will be to meet communications requirements of people on the move."

However, most of these cellular systems were deployed in the metropolitan areas and most of the planned PCSs are targeted for high population density areas. This means that the majority of the planned PCSs are not the truly **anywhere-type** PCS service, but localized wireless services that are designed to capture the more lucrative metropolitan market. A true global PCS has to provide service **anywhere**. Therefore, PCS delivered by satellites that provide anywhere-type of services will be an integral part of the PCS networks and provide cost-effective PCS services **anywhere** in the world.

2. *Evolution of Satellite Communications*

There are now several system approaches to provide satellite-based PCS. These approaches differ in their orbit selection and are therefore being identified as Low Earth Orbit (LEO), Medium Earth Orbit (MEO) and Geostationary Earth Orbit (GEO) systems. To understand the merit of each system, one has to understand the evolution of communications satellite technology.

In October 1945, Arthur C. Clark wrote his now famous technical paper "Extra-terrestrial Relays" on geostationary communications satellites. However, the first communications satellite, ECHO 1, launched in the summer of 1960, was a MEO satellite. Due to the limitation of launch vehicles, most of the early communications satellites were LEOs or MEOs. These early LEO or MEO communications satellites had several major system disadvantages:

a) LEO and MEO orbits required many orbiting satellites to achieve continuous global communication;
b) Since the satellites were not "stationary," they needed a tracking antenna to establish communication between the satellite and the ground station. Tracking antennas could be rather expensive;
c) Due to the limitation of electronics technologies in the 1960s, all these LEO and MEO satellites had very limited capacity.

These system disadvantages did not make the LEO and MEO systems particularly economical, and by 1964, LEO and MEO satellites were replaced by GEO communications satellites.

Since 1964, almost all commercial communications satellites have been GEO satellites. With the development of satellite technology, the GEO satellites for communications became bigger and more powerful. Nowadays, an FS-1300 class satellite from Space Systems/Loral can supply over 10 kW DC power and weighs over three tons.

However, the geostationary orbit poses two basic problems: 1) the inverse square law for signal, where signals in space attenuate in proportion to the square of the distance they travel. This means that communication with satellites 36,000 km away requires a very large satellite antenna to be able to communicate with small, low power handset units; and 2) the long delay associated with geostationary satellites, which degrades voice quality and causes latency problems in data or interactive multimedia communications.

In addition, the geostationary orbit becomes very crowded because the ability of an antenna on the ground to discriminate among satellites is limited by the size of the antenna. A small handset with an omni-directional antenna has no capability to discriminate among different satellites. Therefore, it is very difficult for two or more GEO mobile satellite services (MSS) satellites to share the same frequency band. With very limited MSS spectrum available, the inability to share spectral resource will make it extremely difficult to coordinate among GEO MSS systems.

In the 1980s, the technological revolution in personal computers and micro-processors also revealed the flaws of the centralized mainframe computer. Similar to mainframe computer, the big GEO satellites offer one-size-fits-all services, with little ability to control the flow of information or to interact with it. To achieve economy of scale, most of these big satellites have long in-orbit life, from 12 to 15 years. However, with the rapid development in telecommunications technology, several generations of new telecommunications technology can be developed in 12 years and many new telecommunications services may also be demanded by the market. The centralized and rigidly designed GEO satellites will not be adaptable to technology and market changes.

In considering the limitations of geostationary satellites and the trends of mobile communications, two groups of engineers proposed two LEO satellite-based global PCS systems in their applications to the FCC in 1991. Globalstar, from Loral and Qualcomm, proposed a 48-LEO satellite system to provide worldwide PCS services. Iridium, from Motorola, proposed to use 77 (later changed to 66) LEO satellites to provide global PCS services. In addition, Odyssey, from TRW, proposed to use 12 MEO satellites to provide similar services.

Facing the challenge of global PCS from Globalstar and Iridium, Inmarsat, an international consortium, decided to form ICO (Intermediate Circular Orbit) Global Communications in 1994. ICO also proposed to use 12 MEO satellites to provide global PCS services, similar to the Odyssey approach.

Not wanting to be left out in the MSS market place, both Hughes and Lockheed-Martin then proposed to launch GEO satellites for regional MSS services. These GEO satellites are extremely large. For example, the APMT satellite proposed by Hughes will be 5 meters tall, with lift-off mass of 4.6 tons, and carry a 16 meter antenna.

The next five years will be very exciting in the satellite-based mobile communications market. These proposed LEO, MEO and GEO systems will be competing for spectrum, for capital and for customers with both existing cellular systems and rapidly expanding PCS systems. The marketplace and the consumer will be the final judge on all these different satellite-based mobile communications systems.

3. The Ultimate PCS Vision

The ultimate vision for PCS is to provide cost-effective PCS extension to areas that cannot be economically covered by conventional PCS or cellular cells. A satellite-based system alone would not have the capacity to provide a global PCS service. Partnering with existing cellular or PCS systems would be the most logical and cost-effective choice for MSS to provide PCS extension service.

Another vision is that PCS end-users can use a single handset or pocket-size communicator anywhere: inside buildings, on city streets, or in rural areas. To design and manufacture a low-cost pocket-size PCS communicator for all locations, this anywhere-type personal communicator must derive its transmission technologies from a common technological basis or a common platform. The common PCS technological platform for one leading system is code division multiple access (CDMA), a cost-effective and spectrum-efficient technological platform for wireless communications.

Based upon CDMA, these PCS services can provide end-users with integrated PCS services including voice, data, fax, message and position location services. Basic service parameters are as follows:

Voice: Near-toll quality digital voice;
Data: 4800 bps @ $BER=10^{-6}$, higher data rate & packet data optional;
Message: Paging or two way messaging;
Fax: Group 3 & 4
Others: Many other service options available

The CDMA technology platform allows users to carry the same personal communicator anywhere. This single unit- multiple service concept is based upon CDMA technologies that have already been developed for cellular and PCS.

4. Frequency Sharing

Although WARC-92 allocated some frequency bands in the L- and S-bands for Mobile Satellite Services (MSS), the total available bandwidth is not sufficient if it is divided among service providers. Thus, the same frequency band must be shared on a dynamic basis among different systems. Dr. Yasuo Hirata of KDD, Chairman of CCIR Working Group 8D, recently stated that "one of the most important and urgent subjects presently given to the Working Party 8D is to develop the sharing criteria between Geostationary Earth Orbit (GEO) and LEO systems and between different LEO systems. In particular, the multiple access technique (FDMA/TDMA/CDMA) should be carefully determined so as to avoid the harmful interference to other satellite systems using the same frequency bands. CDMA seems (to be) a very attractive scheme for this purpose."

More important, spread spectrum CDMA is more effective for wireless digital communications than other forms of multiple access techniques. Wireless communications are an interference-intensive environment. Noise-like spread spectrum CDMA signals can best counter interference. As stated in Shannon's information theory, the "best" signal for the "worst" interference will appear as wideband Gaussian noise to the outside observer. Since, in wireless communications, interference, either from one's own system or from other systems, cannot be avoided, the solution is for all systems to employ noise-like signals. Thus, for any particular user, all interference will appear as wideband noise, against which digital signal processing receivers are most effective. Spectrum spreading CDMA will be one of the most effective communications techniques for wireless communications.

5. Global Spectrum Allocation for PCS

The 1992 World Administrative Radio Conference (WARC 92) of the International Telecommunications Union (ITU) resulted in a worldwide allocation for mobile services in the 1.7 to 2.69 GHz band. Resolution 212 of WARC-92 stated that "the CCIR has recommended the 1-3 GHz band as the most suitable for Future Public Land Mobile Telecommunications Systems (FPLMTS)." It also stated that "the implementation of the satellite component of FPLMTS in the bands 1980-2010 MHz and 2170-2200 MHz is expected to be necessary by the year 2010."

This WARC-92 resolution initiated the development of the framework for a global-compatible PCS network known as the FPLMTS. It also identified satellite as an integral part of the global PCS allocation. However, allocating spectrum for PCS application in individual countries will be a challenge to us all.

However, for FPLMTS or Global PCS to be fully implemented, nations must provide appropriate regulatory and business environments to enable the LEO systems to be efficiently used for PCS services to the underserved areas.

LEO Satellite-based PCS Extension

A critical starting point is gaining an understanding of the basic difference between the planning for geostationary orbit (GEO) satellite systems and for LEO satellite systems.

- It will not be practical to define an orbital slot for LEO satellite systems. The current orbital arc registration system is not applicable to LEO systems. Therefore, nations must agree on methods for efficient frequency sharing and for coordination with minimum administrative effort. *A priori* planning or allotment plans based on orbital slot would only leave fallow the spectral resource for a nation and inhibit or preclude the use of the latest communications technologies.

- Unlike large size user terminals used in the GEO systems, such as VSATs and INMARSAT Standard A terminals, efficient LEO PCS provide MSS and PCS to users with pocket-size hand-held terminals.- It will be very difficult, if not impossible, to regulate the movement and usage of these pocket-size user terminals. The economic trend in communications is toward faster, more reliable and convenient modes of operation, i.e., mobile communications to users with small-size phones. Therefore, a more flexible policy towards the implementation of LEO MSS systems and the transport of hand-held terminals across national boundaries is required.
- Most of the GEO satellite systems are national or regional systems that provide services to a limited area. A LEO satellite system, by definition, is international. The emergence of LEO MSS technologies and applications blur the previous boundaries among countries and among services. Thus, more flexible policies concerning multinational system use and more timely procedures to assist international coordination are necessary.

6. *Availability and Utilization of the FPLMTS Bands*

WARC-92 had allocated the 1885-2025 MHz and 2110-2200 MHz bands for use, on a worldwide basis for FPLMTS. The World Radio Conference of 1995 (WRC-95) also indicated that " the availability of the satellite component of the FPLMTS in the band 1980 - 2010 MHz and 2170 -2200 MHz simultaneously with the terrestrial component of the FPLMTS bands. . . . would improve the overall implementation and the attractiveness of FPLMTS to both developed and developing countries." However, the actual availability of the frequency bands are still questionable.

In the United States, the 2 GHz frequencies proposed for PCS are presently in use in some areas of the country in the form of point-to-point microwave systems and private operational fixed service. Under recent FCC regulations, licensed PCS operators have to negotiate with those incumbent users and compensate them where necessary when they move incumbent users to other frequency bands.

The recent PCS auctions in the U.S. in which the FCC collected US$7.3 billion in license fees, have created an upheaval in the PCS industry.

The requirement for negotiation and compensation to the incumbents may be feasible for PCS on a localized basis, e.g., city by city or county by county. However, such a requirement would not be practical for satellite delivered PCS. By definition, satellite-based PCS is national or regional, and LEO satellite-based PCS is international. Successfully negotiating with thousands of incumbent users in thousands of towns, cities, counties and countries simultaneously and reach an agreement among all the parties within a short period of time is almost impossible. The requirement for frequency coordination with incumbent users is feasible, but the requirement for negotiation and compensation to incumbent users for satellite-based PCSs only kills the emerging PCS services in its cradle. A PCS system without satellite coverage is only a localized PCS, not a true anywhere PCS and the time and costs for a satellite-based PCS system to negotiate with thousands of incumbent users are also prohibitive.

The auction approach will also be detrimental to the development of global PCS. Many satellite projects are high risk and long-term in nature. Satellite system

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providers and investors have to put hundreds of millions dollars for the development of the satellites, which may take several years to complete. Then, all the satellites need to be launched into the right orbits. Only after satellites are placed into the right orbit and are functioning properly can the service providers start to provide services to end users and start collecting revenues.

Even though the return on investment (ROI) is relatively high for most satellite projects, the auction approach adds another serious risk factor to the satellite-based PCS system and may prohibit potential investment in a satellite-based PCS system. No one knows the actual value of a MHz spectrum in a particular band or in different countries. When every country follows suit and demand auctions payments from LEO PCS providers even before the project is launched, the dire financial constraints and great uncertainty would greatly hinder the development of any global PCS project. Thus, auctioning the spectrum for the global PCS will impose a prohibitive cost and prolong regulatory delays to the emerging PCS services. Neither service providers nor end-users can afford the additional cost and uncertainty due to the auction of PCS spectrum. Global PCS, the ideal communications service for the 21st century, may be killed by imposing spectrum auction on LEO satellite-based global PCS system.

7. *Planning Strategies for Global PCS*

To take advantage of the potential benefits of the LEO MSS systems, nations should develop a flexible regulatory policy to permit usage that is adaptable to dynamic changes in communication needs and promotes rapid advancement of telecommunications technology. These policies should include the following basic elements:

- Allocate within each country the WARC-92 allocated L-band (1610 to 1626.5 MHz, uplink) and S-band (2483.5 to 2500 MHz, downlink) for LEO MSS systems to allow LEO MSS to fully develop their potential without severe interference from existing systems.
- Minimize use of these bands by terrestrial services such as point-to-point microwave. Control, or restrict use of these bands by industrial, scientific, and medical equipment.
- Prepare proposals and support efforts to simplify the existing regulatory process for international spectrum management and coordination. The existing regulations are too rigid, outdated, and not in pace with technology and changing market demands. The telecommunications administrations of the world should initiate steps to simplify international frequency coordination during the next WRC or support initiatives of other administrations in this regard.
- Develop domestic or regional policy to allow multiple entry, i.e., allow multiple LEO MSS systems to operate in the world and to provide different services to consumers so that users can get the maximum benefits of multiple LEO MSS systems, including service and pricing options.
- Develop flexible operational rules and technical parameters for LEO MSS systems so that no fixed allotment plan is required and the latest telecommunications technologies can be introduced in a timely fashion.
- Prevent auctioning of spectrum for satellite-based PCS. Auctioning of MSS spectrum only hinders the development of global PCS and prevents consumers, especially those from developing countries, from gaining the benefits of the emerging PCS services.
- Allow multiple PCS technologies, such as CDMA and CT-2, to operate within the same FPLMTS band with proper

frequency sharing arrangement. The consumer and the market place will select the most cost-effective and spectrum efficient technology.

The main objective of the global PCS policy should be to ensure that MSS can be provided as a free market commodity to all people in the world, driven by demand and regulated by a simple and consistent set of rules throughout the world. With this objective, PCS end-users and telecommunications administrations will obtain the maximum benefit from the emerging MSS.

8. Summary

To prepare for the upcoming revolution in PCS, nations must develop strategies and regulatory regimes to take full advantage of the emerging personal communications technologies introduced by the LEO MSS systems. These should include policies promoting:

- Multiple entry for LEO MSS systems
- Flexible regulation for LEO MSS and small hand-held units
- Advanced communications technologies, such as CDMA for efficient use of the spectrum and for frequency sharing among different systems
- International cooperation to fully use the benefits of LEO MSS.

With these strategies, nations can make full use of LEO MSS systems to provide low-cost PCS services to all users, anywhere in their countries.

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A New Strategy for Nation-wide Research and Development under Competitive Information and Telecommunications Environment in Korea

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ABSTRACT

Over two decades, Korea has deployed nation-wide R&D strategy to develop IT technologies systematically. The main idea behind the strategy was that government leads the R&D program to strengthen national competitiveness. Recent changing telecommunications environment, however, demands a different R&D framework.

1. INTRODUCTION

Over two decades, Korean information and telecommunications(IT) industry has rapidly grown from the level of assembling simple parts to being counted as one of industries having global competitiveness. Leaderships of the Korean government for IT technology development and the enhancement of manufacturing technologies in Korean IT firms have contributed to the growth. The government has developed IT technology in the form of large-scale research and development(R&D) projects. Among their products were a series of time division digital switch called TDX, optical transmission system, high-performance computers called TICOM, and code division multiple access (CDMA) system, etc.

The purpose of technology development by large-scale R&D projects is to attain to technological edge within short periods by concentrated investment in a few specific technologies. Under the prospect that IT technology will decide future competitiveness of nation, the government classified IT technology into one of national core technologies requiring immediate technology development, and employed the policy that government provided opportunities for new markets.

Recent changing telecommunications environment, however, demands a different R&D framework. Competition was introduced in telecommunications service industry and IT market has been opened. Under new IT environment, the traditional nation-wide R&D strategy does not work well any more. There are many efforts to modify the R&D strategy to fit with new environment in Korea. In this paper, traditional nation-wide R&D framework and new requirements under new IT environment will be reviewed.

2. GOVERNMENT-DRIVEN LARGE-SCALE R&D STRATEGY

Most of IT technology in Korea has been developed by itself because the effectiveness of Japanese approach is impressive in which technology development by itself results in economic growth and technology progress. Since the accumulation of technology and R&D funding in Korean IT firms were poor in 1970s, it was almost impossible for them by themselves to develop technologies requiring massive investment such as switches, semiconductors. Thus, the Korean government shaped a government-driven IT technology development policy to enhance competitiveness of IT firms and to upgrade IT technology level. The logical basis for government-driven IT technology development policy is on the following three points:

- IT industry generally has a large ripple effect on the other industry because it forms a infrastructure of national economy.
- The high risk of R&D, massive investment, integration of several technologies, and the speed of technology change prevent IT firms from venturing into starting R&D. Only the government can initiate and control such R&D.
- Information infrastructure affects national competitiveness, and the government should take actions to enhance the competitiveness.

The basic steps for government-driven IT technology development in Korea are as following:

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- first, the project is carried out by government-funded research institutes.
- second, the research institutes transfer the acquired technologies to IT firms.
- third, IT firms modify and improve the resulting products.

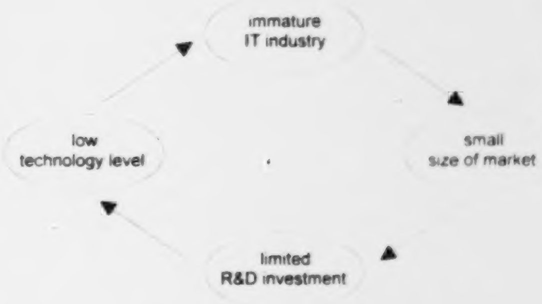

Figure 1. Cycle of IT Industry Environment at the Primitive Stage in Korea

It was believed that this approach results in upgrading national IT technology level within the shortest periods. As shown in Figure 1, market size is small at immature stage of IT industry. Small market size limits R&D investment. With the limited R&D investment, technology cannot easily be accumulated. With such level of technology IT industry cannot be matured. To break this cycle, the Korean government shaped a government-driven technology development policy in which a few strategic technologies are selected and invested with massive capitals. The criteria for selecting technologies are as following:

- The technology should have larger ripple effect on the other sectors.
- The R&D of the technology should require so massive investment that each IT firm cannot afford it.
- The products resulted from the development of the technology should be able to make profit more than the investment.
- The technological know-how of IT firms should be easily accumulated through technology transfer from the research institutes.

The IT projects selected on the basis of the above criteria includes the development of time division digital switch, the development of high-performance computers, and the development of code division multiple access system, etc.

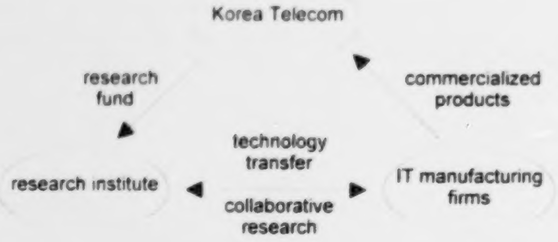

Figure 2. Framework of Large-Scale IT R&D Strategy in Korea

The basic framework of government-driven large-scale IT R&D strategy before 1995 is depicted in Figure 2. Korea Telecom(KT), a government-owned telco, provides the research institute with research fund. The research institute develops a prototype in collaboration with private manufacturing firms. The firms commercialize the R&D products and deliver the commercialized products to KT. It was believed that this system contributed to enhancing the level of national IT technology within short periods. This system has worked well because the government controls telecommunication charge rate so that the telco can afford not only providing massive research fund but also buying a lot of the resulting products. Full support of the government and the selection of the technology that the demand of resulting products is beyond break-even point for not only manufacturing firms but also KT, have contributed to the R&D strategy. The R&D strategy employed several tactics.

o Establishment of Government-Funded Research Institute
Government-funded research institutes were established to perform large-scale R&D projects because private firm's research laboratory has poor technology resource and the risk of the R&D is so high. The research institutes perform R&D projects throughout several stages including basic research stage, applied research stage, and production prototype stage, and finally transfer acquired technologies to IT firms. Thus, the research institutes play a central nervous system role in most government-driven large-scale IT R&D projects.

- Purchasing Policy of R&D Products
  The most attractive policy for manufacturing firms was to guarantee purchasing an amount of products enough to make profits. At the early stages of TDX project the firms doubt the success of the project due to high risk of R&D and their inexperience. Guarantee of purchasing the resulting products, however, makes them to involve actively into the project.

- Technology Transfer Policy
  Early involvement of manufacturing firms into the projects is devised to ease technology transfer. The firms modify the prototype to commercial products with know-how accumulated by their production experience.

This IT R&D strategy has several advantages. The technologies in the selected IT areas have been rapidly progressed. The personnel involved in the projects gains confidence on large-scale R&D. Collaboration among government, research institutes, and firms, is well organized. The project with high risk can be set out. In the other sides, it has several disadvantages. The IT areas to which R&D resource is not allocated make sluggish progress. As a result, the import of the associated assembly parts in the IT areas increases as the production of commercial products increases. In additions, the importance of research institutes is growing in the collaborative projects. Above all, it is a critical problem that the acquired technologies are not accumulated in KT that provides most research fund.

3. A CASE OF DIGITAL SWITCH DEVELOPMENT

The first IT project selected on the basis of the above criteria was the development of a digital switch. In '70s, the demand for telecommunication services in Korea had exploded due to the economic growth. The telecommunication industry could not meet such exploding demand. The lack of technological competency partially attributed to it. The unfilled telephone demand became a serious social problem(1, 2). Moreover, it was believed that insufficient telecommunication services restrained the economic growth. Thus, the Korean government sought technological alternatives to resolve the problem, and finally selected digital switch technology. Electronics and Telecommunications Research Institute(ETRI) has been established to develop digital switches (2). In 1978, ETRI started a preliminary study on the digital switching system. ETRI developed a prototype with 96 subscriber capacity in 1979, and a prototype with 200 subscriber capacity in 1980 (2, 3). In 1981, a prototype with 500 subscriber capacity was developed and deployed in the rural area for test operations. With the feedback from the test operations, a production model switch with 10,000 subscriber capacity, called TDX-1, was developed. For commercialization of this model, four major manufacturing firms took part in the TDX project. At last, the first commercial digital switch with 10,240 subscriber capacity, called TDX-1A, was developed in 1986. The successful development of TDX-1A brought confidence on technology development to engineers and on the development of digital switch with larger capacity to managers. As a result, the development project of digital switches with large capacity called TDX-10 for urban area has been set out. Government, research institutes, a telco, and manufacturing firms collaborated to develop TDX-10 from the initial stage (3). The development of a series of digital switches has been named a typical successful development case in Korea (4), and become a model for IT projects, to name, semiconductor development, high-performance computer development, optical transmission system development, and CDMA technology development, etc.

4. EFFECT OF RECENT TELECOMMUNICATIONS ENVIRONMENT CHANGE

Like other countries, the deregulation of IT services was adopted in Korea. DACOM came to the international IT service market in Korea. Korea Mobile Telecom started providing wireless services. In 1996, several private companies have been granted to provide specific telecommunication services. Thus, there is no monopolized company in telecommunication service area except local phone call service in Korea. Introduction of deregulation requires change of large-scale R&D strategy. The firms, which took part in large-scale R&D projects including TDX project and optical transmission system development, are now competing with KT because they have been granted to provide telecommunication services. Now KT raises a question if KT should continue providing R&D fund for enhancing national IT technology. KT claims that it is not fair that KT provide R&D fund for all IT industry because KT is not a monopolized public telecommunications service provider but one of service providers. It is a conflicting point that some profits of KT are invested in the technologies for service providers competing with KT in current large-scale R&D strategy. KT lost interest in the projects that cannot make profits directly to KT. Current large-scale R&D strategy does not guarantee fairness under new IT environment. Furthermore, the plan of cutting government's portion of KT stock contributes to claims for the change of current large-scale R&D strategy.

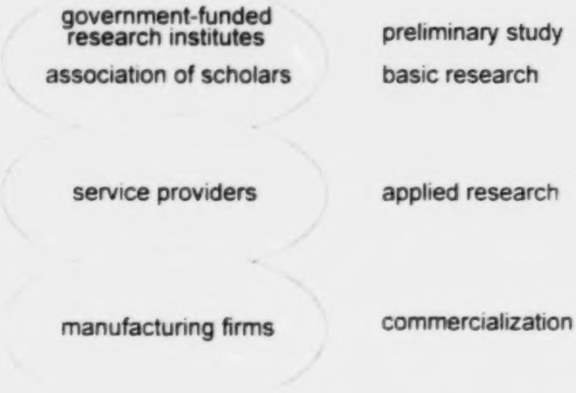

Figure 3. Research Areas in New R&D Strategy

5. A NEW R&D STRATEGY

Several new large-scale R&D strategies are proposed and reviewed. Among them is a R&D strategy for Future Public Land Mobile Telecommunications Systems (FPLMTS) development project that is to provide FPLMTS services in 2002. As shown Figure 3, service providers, manufacturing firms, association of scholars, and government-funded research institutes forms a grand consortium to carry out FPLMTS project. The consortium resembles the current R&D strategy in that several parties collaborate. However, the consortium is different from the current R&D strategy in that each participating body has its own research area as well as in that service providers can accumulate the acquired technologies. The research institutes and the association of scholars will carry out preliminary study and basic research at the early stages. After that, the consortium will be formed to carry out applied research, prototype building, test, and commercialized products production. Service providers will develop service technologies. Manufacturing firms will develop core parts and the whole system.

In grand consortium strategy, KT will take part in projects as a service provider. Thus, KT will contribute research fund at the same portion as competing service providers. Difference in research areas among participating bodies is to remove any dispute whether the government assists the project or not. Government-funded research institutes had carried out projects at preliminary stage as well as at production prototype development stage. However, in new grand consortium strategy research area of the research institutes will be limited to basic research and to applied research. The government-funded research institutes will no longer carry out system development.

After preliminary study or basic research has been carried out, the participating bodies will cooperate in some research areas and compete in the other areas. Since the demand of developed commercialized products is guaranteed over a fixed quantity in current R&D strategy, participating firms have a tendency to defer the improvement of the products until collaboration stage has been finished in order to gain competitive edge over the other competing firms. It was pointed as one of causes that deteriorate cost competitiveness of developed products. Purchasing policy that guarantees the demand of the developed products over a fixed quantity provides a momentum to expedite the progress of the project in a short term. However, it may be a cause deteriorating competitiveness of developed products in a long term because the firms do not continue improving the products after a certain period has been passed. It is shown by a case of TDX products that lost its initial competitiveness over competing foreign products after a few years has passed.

In new grand consortium strategy, there are several issues to be resolved including decision on each body's portion of research fund, allocation of research fund, and decision on who will possess the patents resulting from collaborative research, etc. In this strategy basic research might be neglected. However, at the early stages when firms hesitate in involving into projects, the research institutes and the association of scholars can carry out the research and provide its results to the firms. Another issue to be resolved is how to prevent the competing bodies from being neglecting collaborative research and carrying out core research exclusively without distributing its results. Since several bodies involved into the project throughout several stages, a mechanism preventing them from repeating similar research and delaying distribution of the results should be devised. A policy inducing firms into projects should be needed because any purchase of developed products is no longer guaranteed. It might be a good method that preliminary study is carried out so thoroughly that firms gain confidence in successful development and global competitiveness of resulting products.

6. DISCUSSIONS

Korea has deployed nation-wide R&D strategy to develop IT technologies systematically. The main idea behind the strategy was that government leads the R&D program to strengthen national competitiveness. The strategy has been described and detailed. It was believed that it was very efficient R&D strategy.

Recent changing telecommunications environment, however, demands a different R&D framework. Competition was introduced in telecommunications service industry and market has been already opened. With this change, the traditional government-driven R&D strategy does not work well any more.

There are many efforts to modify the R&D strategy to fit with new market environment, in Korea. Among them is a grand consortium strategy that is under review as a nation-wide R&D strategy for FPLMTS development project. The consortium resembles the current R&D strategy in that several parties collaborate. However, the consortium is different from the current R&D strategy in that each participating body has its own research area as well as in that service providers can accumulate the acquired technologies. The grand consortium strategy has several advantages including its fairness to KT.

Grand consortium strategy comes into an alternative of new R&D strategy. FPLMTS projects will show if grand consortium strategies become a new R&D strategy, and shape the strategy with facing the issues to be resolved.

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The Internet: Small Firms, Intranets, and Distance Education in Latin America

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1. ABSTRACT

Institutions, small firms, and individual members of communities in Latin America are beginning to experience basic telecommunications infrastructure, only to find that they must now leap to become part of the Global Information Infrastructure. Internet access is crucial if they are to progress socially, democratically, and economically. The potential is great for educational institutions to extend their reach both nationally and internationally through distance education and training, for small firms to compete nationally and internationally, and for individuals to become members of global "virtual communities" with common interests joining them through space and time. Cooperation across North-South economic lines, across institutional, governmental, academic lines, and across regulatory frameworks governing the convergence of technologies will bring Latin America into Cyberspace. It is to the benefit of industrialized countries and developing countries that the information gap be narrowed, not that the breach grow wider.

2. INTRODUCTION

How much does it cost to communicate? How much does it cost to *not* communicate? In the 1960s and 1970s, Latin American scholars related communication to sovereignty and national identity. They protested their inability to communicate with the North, on an equal basis, because of the inequality of information flows. This imbalance, the inability to communicate equally, with the industrialized nations was perceived as a threat to identity and sovereignty.

In the 1980s, the region recognized the need for restructuring government in order to achieve their goals for social and economic progress. These changes were dependent upon information, on national infosructures that were lacking. Without adequate telecommunication infrastructures, the infostructures for education, health, governance, business, and the international markets needed for export would be impossible. They all demanded communication and information access that existing telecommunication infrastructures could not support. In an effort to modernize, regulations governing investment, ownership and operation of telephone systems were changed. Liberalization swept the region.

Now, in the 1990s, Latin America understands that access to the Global Information Infrastructure (GII), Cyberspace, is crucial to avoid isolation from the North. Its citizens need to join the "virtual communities" trying to solve similar problems, to share with communities that are drawn from many nations. Increasingly, *democracy*, as well as the global marketplace, requires admittance to the information laden Internet.

3. DEMOCRACY AND CAPITALISM

Latin America, with cities older than most of those of its northern neighbors, did not begin to fight for its unique identity as a region until the 1960s. Hopes arose in the 70s as economies improved and democracies were born. In the 80s, most countries began to strangle on debt burdens, to grow hungry as capital took flight, and to face new challenges - the problems of democracy. The sometimes siren song of democracy had carried the promise of Freedom. Freedom from dictatorships and political repression, freedom from the prison of poverty, and above all, the freedom to become better, to grow. But freedom from dictatorship is nurtured and grows only in the presence of individual and government responsibility, freedom from poverty comes only with increased opportunities. The bright freedom to become, to hope for a better future, is tarnished with the dark bitterness of empty illusions when hope is destroyed.

Democracy is not easy. According to Jeffrey Archer, Member of Parliament, Great Britain, "Democracy takes time. Dictatorship is quicker, but too many people get shot" (WEMU). Capitalism is not easy. Just as there are different forms of democracy, so are there different forms of capitalism. It is self evident that the template for one nation's democracy, any more than its template for capitalism cannot be imposed, efficiently and effectively on another. As cultures differ, so does the perception of power, the collective needs of a society as they balance against the needs of the individual, and the concept of governance and accountability. However, we can argue that as participation in governance by all sectors of the population is increased, and as participation in capitalism by all sectors of the population increases, democracy is strengthened, capitalism is democratisized. And as access to the political decision-making process decreases, as access to the rewards of capitalism decrease, democracy is weakened and capitalism is de-democratisized. This access relies on telecommunication technologies.

During the 1970s, expectations rose as middle classes grew and enjoyed the fruits of the marketplace. Then came the "lost decade" of the 1980s, when most Latin American countries simultaneously experienced a debt crisis, while competing with East European countries from the former Soviet bloc for investment capital, portfolio, joint-venture, and other forms of investment needed to liberalize the economy.

The 1990s brought an overall decrease in inflation from a 196% level in 1991 to 19% in 1995. This was accompanied by budget deficits falling from an average of 5.5% of GDP in 1988 to 1.8% last year. These positive figures are offset by an average of 13-15% of GDP spent on security expenses, both public and private, with private armies sometimes becoming paramilitary squads (Economist, 1996, pp.19-21).

Violence, corruption, government mismanagement, smashing debt burdens, currency devaluations and the rigors imposed by the IMF on some countries to implement financial reforms have stunted the growth of their middle classes, and even tested nascent democracies. Many economists predict the need for 6% growth in the region to reduce poverty as populations rapidly increase. We know there is a direct correlation between the birth rate in a country and the average level of education of its members. We also know that some form of liberalization of the economies in the region is needed, and that small businesses need to grow. Access to education and telecommunication technologies is part of the answer.

Chile has prospered and some others have improved, e.g. Peru, Bolivia. Still others have been on a roller coaster, e.g. Mexico, and we, of Venezuela, have watched our country win the title of worst performing economy of Latin America for the last two years in a row. The World Bank Annual Report calls 1995 a year of "mixed results" characterizing economic performance. "About one fourth of the region's population lives on less than $1 a day. The poorest 10 percent-to-20 percent live in rural areas...(where) rural poverty tends to be concentrated in remote areas with low agricultural productivity and few nonfarm jobs". The shifting mosaic of social progress and healthy economies colors the lives of millions who belong to the South.

4. TECHNOLOGY TRANSFER: NARROWING THE INFORMATION GAP

In the 70's, it was argued that technology transfer would permit developing countries (DCs) to leapfrog the North-South chasm. The frog never leapt. Then it was argued that "appropriate technologies" would close the gap. The chasm still yawns. Now, the technologies of advanced telecommunications infrastructure, frequently also the most appropriate technologies, are holding the most hope. At no time in our history has the frog been bigger and stronger and the gap easier to jump. The relationship of telecommunications infrastructure to social and economic progress is no longer questioned, so we are given another chance, perhaps the last one, to share each other's worlds. But in order to narrow the gap, new partnerships must be forged, new strategies formed, and stakeholders in the future of the region better defined.

Cyberspace depends on a developed multimedia structure that Latin American countries lack. The most developed countries lag far behind the industrialized countries. The Table 1 indicators tell the story:

TABLE 1. MULTIMEDIA INFRASTRUCTURE INDICATORS

	Telephone density	TV Density	PC Density	Rank
		SOUTH		
Argentina	14.10	39.00	1.70	25
Chile	11.00	23.00	3.10	29=Turkey
Mexico	9.20	20.00	2.20	31
Brasil	7.40	29.00	0.90	32
Venezuela	10.90	18.00	1.30	33
		NORTH		
USA	59.50	79.00	29.70	1
Denmark	60.40	55.00	19.30	2
Canada	57.50	65.00	17.50	3

Source: NETWORK WIZARDS AND INTERNET SOCIETY, OAS
(http://www.oas.org/EN/PROG/RED/esting03.htm)

Source:ITU World Telecommunications Indicator Database
Main telephone lines, television sets and personal computers per 100 inhabitants, major economies, 1994
(http://www/worldbank.org/html/fpd/technet/multi.htm)

The need and initiative to access the Internet are reflected in the exponential growth of hosts from July of 1994 to July of 1996 in the region:

Brazil	5,896-46,854
Mexico	5164-20, 253
Chile	3,703-13,239
Argentina	248-9,415
Colombia	144-5,265
Costa Rica	544-2,582

These figures do not breakout organizational domains, therefore it is difficult to tell what kind of organization is increasing connectivity (org, com, edu, net) and which sectors of the population are involved.

5. SMALL FIRMS AND INTRANETS

The majority of enterprises in Latin America are family-owned and they are the major employers of the labor force, although most would be considered small businesses in the United States. Internet servers are a barrier to access for many of these businesses because they are unable to purchase and support the technology. However, virtual servers, would permit them access and the ability to build their own intranets with their provider giving them control and security over their information. This would dramatically increase Internet usage, and lead to even greater access for other members of society.

6. SMALL FIRMS AND DEVELOPMENT

Increasing the growth of existing small firms and increasing their numbers is key to the development of Latin America. Even in the United States, small firms, owned by women, employ more people than all of the Fortune 500 companies combined. These women-owned businesses generate pay checks for one out of every four employees in the U.S. There, many small business owners, or potential owners have access to further education or training. Latin American access to further education, training, and relationships with mentors, is particularly key to business development where there is an overwhelming need to develop successful businesses. Latin American demographics of current Internet users, combined with information on industrial sectors, would allow distance education classes to be tailored to the needs of those most likely to participate via the Internet.

The informal business sector flourishes in many countries of the South, dotting the sidewalks, inhabiting small rooms, extending from urban to rural areas. Although these jobs provide income to population sectors who are excluded from the formal economy, there is also a negative correlation of the informal sector to the rate of economic growth in a country. The data suggests that increases in the informal sector contribute to negative economic growth by "reducing the availability of public services for everyone in the economy, and, secondly, increasing the number of activities that use some of the existing public services less efficiently or not at all" (Loayza, 1994).

Bringing this population into the formal sector is crucial to improving the socio-economic development of a country. A combination of reformed government regulations and tax mechanisms, accompanied by access to capital and information is one way of transforming the informal sector. Some examples of "good practices," if not best practices in training and improving access at a grassroots level in Latin America follow:

- Sponsorship was located for a loan to women program by a voluntary organization. Resources were increased by putting together an advisory board of government and private people to assist, thereby allowing the women to further draw upon the resources of the organizations and people on the advisory board.

- Another sponsor organization manages the revolving fund for three years, but group members are trained to take over at the end of the three years; another fund has an extensive training program for its directors, managers, and group members. Case studies and coursework include learning accounting, budget control, control of defaults, how to use borrowed money, financial planning, promotional methods, human relations, etc.

- Still another includes within its criteria for loan applications a requirement that women must receive training related to their project *before* submitting a loan application. Next, the applications develop loan proposals that are reviewed for meeting the fund's lending criteria. If the loan is approved, continued regular support is provided by government field coordinators, so that the entrepreneur can build a successful business (ShortTakes).

These are only a few examples where women, education, and increased access to capital, can invigorate the economy. Projects of this nature, are based on communication, using different channels at different stages of the project development. The initial communication with potential entrepreneurs is face-to-face, sponsoring organizations use telephones, and ultimately to grow, organizational connectivity to the Internet is needed. People involved with these projects, at all levels, are building relationships, key to maintaining the projects themselves, and to opening further programs. For example, sponsorship, voluntary organizations, and trainers, may be from the same country, or from another Latin American country, or from other regions of the world.

Linking individuals and groups to each other is a way of building on each others' experiences, a way of bringing pieces of information together to develop knowledge, and a way of supporting each other in building small businesses. Trainers who do not remain where the groups are located, can maintain an ongoing presence, when needed, so that groups do not feel cut off from the rest of the world.

If information centers with Internet links were set up, people who wanted information on beginning small businesses, or formalizing the businesses they already operate, could find government information, voluntary group information, and sponsorship information. Obviously, governments would have to put someone in these centers capable of accessing the information, needed by the potential entrepreneur. These centers could also provide e-mail services for people involved in projects, or wanting to get information, or who wanted to remain in contact with others having to do with past projects. Researchers have demonstrated, for many years, that one of the most important functions of communication in organizations is a socio-emotional one. In other words, maintaining relationships. The importance of relationships in any endeavor in Latin America cannot be overstated.

7. EDUCATION AND ECONOMIC DEVELOPMENT

All countries recognize the relationship of literacy to the socio-economic health of their societies. "Literacy increases the productivity and earning potential of a population". In asking why literacy rates are not higher, the immediate cause is "low levels of enrollment and retention at the primary level". There has been great improvement in school retention for children from six to eleven years of age in Latin America from 1960 to 1990. The number of children not attending school decreased from 43 percent to 13 percent in these three decades. However, the enrollment rates "tend to mask the high absenteeism, repetition and dropout as well as low attainment rates among children" (Chowdhury).

TABLE 2. EDUCATION INDICATORS - 1990 ADULT LITERACY

Mean Years of Schooling				
x	Male	Female	Male	Female
Argentina	8.9	8.5	96	95
Brasil	3.8	4.0	80	80
Chile	7.2	7.8	95	94
Mexico	4.6	4.8	92	74
Peru	5.7	7.1	90	85
Venezuela	6.2	6.4	91	89

Source: The World Factbook, 1995

UNICEF estimates the percentage of primary school age girls out of school as:

Argentina	5
Brazil	no data
Chile	13
Mexico	2
Peru	11
Venezuela	10

Source: UNICEF *The Progress of Nations 1996 - Education*

The statistics for Chile seem quite high in view of a 94 per cent female literacy rate, and quite low for Mexico with a female literacy rate of 74 per cent.

8. DISTANCE EDUCATION

"Poverty and inequality constitute the 'Achilles heel" of Latin American development" (World Bank Annual Report 1996 Latin America and The Caribbean). For this reason, it has targeted human development as a major challenge where the average adult population has 5.2 years of education. This is two years less than other countries with a comparable development level. Without expanding the reach of education and its quality, particularly at the primary level, the region cannot prosper. The problem is exacerbated, because women tend to have a higher drop out rate, and a lower literacy rate. This makes it more difficult for them to help and motivate their own children in primary schools. Distance education has become increasingly important in training educators in primary schools in an attempt to prevent dropouts, absenteeism and in how to involve parents in adult learning programs. Among several projects, one helps teachers plan a classroom environment that is conducive to learning to read. Literacy is the first step from poverty for many.

A number of institutions are already participating in distance education programs in Latin America. They include:

Columbia	21
Argentina	8
Mexico	6
Brazil	5
Chile	3
Venezuela	2
Peru	1

(Source: Distance Education Database)

There are already recognized universities in the U.S. and Europe who are granting undergraduate and graduate degrees via the Internet to Latin Americans, e.g. the Open University in the U. K. and the University of Phoenix in Arizona in the U.S.

Distance education is not a recent innovation. It has existed for decades with the earliest forms, correspondence courses, beginning in the 19th Century, gaining some acceptance as an institutional option by the 1930s. The 1960s brought instructional television, unfortunately with great potential, still unfulfilled. A range of options are available now, ranging from correspondence courses relying on paper to classes using videoconferencing. The Internet is already being used to create "virtual universities" with one effort crossing nation boundaries. The "Virtual Sound University", is an expansion of the Oresund University Network

involving twelve institutions in Denmark and Sweden. (Bollag, 1996, pp A35-36.)
The government of Brasil has several projects including the *Escola do Futuro* (School of the Future) at the University of Sao Paulo with over three hundred participants. *Telecurso 2000* is a joint private bank - FRM (Roberto Marinho Foundation) with over 575 telesalas in hundreds of industrial enterprises, industrial training centers, community centers, and federal penitentiaries. As of the end of March in 1996, there were 1,517 teaching assistants with 40,423 students. The FRM has spearheaded tele-education, already having had fifteen years of experience with other educational programs. FRM is the non-profit organization belonging to Globo TV network. Globo is the fourth largest network in the world, contributing to Brasil's exports by sending *telenovelas* to the rest of Latin America and to Europe, Africa, and even Russia. (Knight, 1996). It should be said that some of these *telenovelas* are groundbreaking social comment, treating serious Sissues that have not been addressed by soap operas in most countries.

There is a huge, underused resource in Latin America, its women. "It is usually the women who are the poorest, the least educated…but they are key to their country's social and economic progress." It has been found that educating women leads to economic improvement in developing countries, and that economic stability encourages social stability and democracy (Shields & Stewart, Forthcoming 1997). As the telecommunications infrastructure of the region is modernized, the infrastructure for distance learning through the Internet is being built. And the possibility of reaching women who will become part of building the economy is increased.

"The strengthening of the role of women in society is of fundamental importance not only for their own complete fulfillment within a framework of equality and fairness, but to *achieve true sustainable development* (italics added)." (OAS, 1994).

Educating women, training them, providing access to capital and information, providing the means for them to reach beyond their present status is probably the most rapid, most efficient, most long-lasting solution open to Latin America as it moves towards a new millennia.

9. THE MODEL

The model of universal telephone access in the USA and some other countries is not necessarily the best model for developing countries, nor the best way of spanning the North-South Gulf. Some authors argue that even in the US, the concept of universal service is a "moving target" and needs to be redefined. As technologies converge, multileveled levels of access need to be defined, e.g. Level One: household access, Level Two: community access, Level Three: institutional access (Hudson, 1995). The concept of multileveled access is particularly relevant to Latin America where community and institutional access are key to socio-economic development. Multilevels of access are probably the best way of providing individuals and institutions a path to the GII.

David Lytel, formerly with the federal Office of Science and Technology Policy under the Clinton administration, envisions a "network of local access centers" in the U.S. where people could go to inform themselves (ICA 1995). These would include community centers, libraries, schools and local government offices. In Latin America, the meeting place of communities is somewhat different. Certainly schools and federal government offices are major information centers or places where people go. Libraries and community centers are not as well developed in Latin America as the U.S, and people meet in other places. Prominent amongst these communal meeting places are churches, marketplaces and public hospitals. Country differences call for identification of locations best serving the cultural needs of each country. Some countries are already accomplishing this in providing access to public telephones. By extension, they could provide information centers having a ramp to the Internet that would connect different areas of a country, connect it to the rest of Latin America, and to the world.

The model we are proposing for distance learning is an interconnected system beginning with radio programs directed to regions where there is no other means of mass communication, extending through television broadcasts, and ending with the most sophisticated technologies. Interwoven in the system are different levels of telephone access. At each stage, or level, stakeholders and constituencies are identified.

Expanding the concept of stakeholders beyond the traditional notion of government, transnational corporations, and the consortia who are owners and operators of telephone systems, allows for voices usually unheard, to be recognized. Many of these groups are crucial to the long-term success of liberalization projects. They may also bring a new perspective or dynamic to the planning process. Some variation of "(t)he 'consensus conference' used in Denmark to integrate the voices of ordinary citizens into debates on specific topics related technology policy might be useful (Sclove, 1996, Shields & Stewart, 1997).

In Bangladesh, a nonprofit organization plans to use telephones to maintain close communication between its rural and city offices. The rural offices will keep the city offices in touch with issues, e.g., agriculture, health, and education, relevant to their rural population. This, in turn, allows the city offices to plan national radio and television broadcasts around these issues. The main city office hopes to use the Internet for communication with its international office, and to find better solutions to problems as they occur.

Already in Bangladesh, phones are beginning to connect villages to cities, national radio and television stations are devoting major portions of air time in promoting public health, the education of women, and modern agricultural methods. Businesses and NGOs are becoming more efficient as they use electronic mail to stay in close contact with their regional offices. Universities are hoping the Internet will become a source of information for them.

The use of interconnected systems of communication and information technologies for education, and the socio-economic development of the region calls for the development of new partnerships, alliances, and consensus on long-term goals for the region.

Our thinking has become straight-jacketed when we define stakeholders and resources. Flexibility in combining resources and alliances raises new possibilities for funding and maintenance of multimedia infrastructures in Latin America.

Traditionally, consortia in Latin America, have not included transnational corporations providing consumer products and services. Resources are perceived to be mostly, governments, banks, multi-lateral lending institutions, and transnational corporations involved in the ownership or operation of telephone systems. This limits the partnerships and alliances that are needed to provide access to the GII for the region.

By expanding the horizon beyond the usual consortia, and partnerships, we can discover other resources. There are other transnational corporations, e.g. those producing consumer products and services, e.g. Revlon, McDonalds, Colgate, Palmolive, and Sony, to name only a few.

There are transnational hardware and software corporations. With the merging of communication and information technologies, the blurring of lines makes it difficult to define corporations, e.g. Microsoft. They all have something to gain from healthy economic development in Latin America.

It is not only ethical, it is intelligent, that multinational firms and the more developed regions of the world strive for better conditions for those countries of the "South". North-South economies are inextricably linked. The shrinking economies of Latin America contributed to the increased trade deficit of the U.S. in the 1980s.

Corporations and consumers can be envisioned as pyramids, with corporations forming the upper parts of the pyramid. Consumers form the lower levels that support the corporations above. If the base and lower levels are weak and unhealthy, the top will crumble.

It would seem wise to educate and train people to form a healthier economy. This would increase the consumer base, and the international markets that sustain corporations. Healthy citizens and corporations also form a better tax base for countries, further aiding them in nation-building. Alliances, partnerships, joint-ventures, and other forms of working together become more flexible when the entire pyramid is stable.

It is this combination of resources, along with other stakeholder NGOs and local grassroots organizations that will lead to learning and away from poverty.

10. CONCLUDING REMARKS

"The growth of the Internet has been the most astonishing technological phenomenon of the last decade of this century" (The Economist, 1996, pp17-

18). Although there is increasing access to the GII in Latin America, exclusion is the overwhelming norm. The costs of exclusion and isolation are unacceptable. It is for this reason that Latin America cannot afford to lose the opportunity of using the Internet for training and education that will lead to social and economic progress. Once again, the question, how much does it cost to communicate is answered, "How much does it cost to *not* communicate?"

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World Wide Electronic Market Place for Tourism on ATM

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Abstract

The paper presents findings from the SAM project (Services and Applications for a World Wide Market Place in Tourism). This project is conducting field trials of a multi media electronic market place for tourism products. The field trials involve users trading with each other across the world. Product types that can be marketed include: activities, events, shopping, places of interest, food and drink, accommodation, tours, and in addition, regions, and cities can be promoted. The market place automatically logs usage events and thus a large body of empirical data has been gathered. The paper will present a description of the the system with Internet, ISDN, and ATM for local and international connections.

1.0 Introduction to SAM

SAM is a world wide electronic market place which enables, tourist boards, hotel owners, owners of sports activities or events, cultural venues, shopping centres, places of interest, restaurants, etc. to trade with travel agencies and customers throughout the world using widely available computer systems and public telecommunications networks. Using SAM these vendors of holiday products can, alone or in collaboration, define their products using a set of standard product attributes, create information about their products -as text, still images, sound, music or video, set product availability and prices, make this information available to potential customers, and negotiate commercial conditions such as specific prices and commission rates. The retrieval and browsing, and the creation of customised holiday packages can occur in the offices of travel agents or tourist boards or, via Internet, at home/office. SAM offers a direct distribution channel and is particularly suitable as a means of reaching the increasingly important individual traveller who prefers to choose each item of his holiday. A key feature of SAM is the continous integration of new product information from point-of-offer so that points-of-sale merely have to use one application for browsing, negotiating, package creation, and booking, for all product sources and types. Thus points-of-sale are provided with access to a wide product resource from which to create their own product range which they can then cost effectively sell. The field trials are assessing the qualities of service which are appropriate for marketing and selling. The results of the trials are being used to refine the business case for the users and value added service providers.

SAM service providers are currently established in 25 countries. The SAM Common Interest Group has more than 1500 members.

2.0 SAM in the Pacific Region

The SAM services were developed from the requirements of tourism company partners. A general key issue is the control destination markets have of product awareness in origin markets. This can be illustrated with reference to partners in the Pacific region.

2.1 SAM in Japan

Although there are some particular short term factors that distort the picture for 1995 (Great Hanshin earthquake, the subway attack) the results for the 1995 financial year show that tourism is an important industry for Japan (the expenditure on tourism is 25 trillion Yen, twice that of consumer electronics), but there is a substantial deficit between inbound and outbound of 42.2 billion$. The trends are clear for outbound travellers, a steady increase every year (nearly 400% since 1979) with 80% of outbound travellers being tourists. (The most popular destination by far is the USA (4.75m), followed by Korea (1.57m), Hong Kong(1.16m), China (0.87), Taiwan(0.82), and Australia (0.74). Europe, particularly Italy and Spain, and S.E. Asia are increasing rapidly in popularity). However the trend for inbound travellers is downwards, with the same number of visitors in the 1995 financial year as in 1990, with some evidence that the length of stay is decreasing. 48% of visitors are on business. Domestic tourism is also decreasing. Japanese tourism companies cannot rely upon wholesale mass market tour operators in potential origin markets but need to develop product strategies on the basis of local costs, exchange rates and desired holiday-makers and then to market to their customers directly.

2 2 SAM in ther USA

Destination markets may have established successful trading but this may be confined to a particular range of products and the destination may wish to establish a broader product range which is marketed internationally This is very important where the local economy is highly dependent on tourism San Diego s visitor industry is the third largest source of annual revenue, generating an estimated $ 3 8 billion in 1995 (Of the 736,000 overseas visitors to San Diego, more than half come from Western Europe (442,000) with an additional 200,000 coming from Pacific Rim nations) It is estimated that 120,400 San Diegans work in fields directly related to the tourism industry which includes lodging, food service, attractions and transportation San Diego s two main attractions for tourists are the world famous zoo and Sea World In spite of its attractions, San Diego has struggled for many years to broaden the typical tourists itinerary from the California *triangle* (San Francisco, Los Angeles, and Las Vegas) paradigm to a *square* that includes San Diego as a fourth destination Utilizing SAM, San Diego will broaden its marketing efforts by complimenting its existing big-name attractions with small and medium sized tourism destinations so as to appeal to a broader audience San Diego s Convention Visitors Bureau, which will be a hub off of the Berkom USA RSP, has rcently implemented a network upgrade which fully supports the SAM application

3 0 Application Design and Implications for Telecommunications

The SAM system has been designed from a consideration of the communication tasks of users the types of information that they will transfer, the communication methods they will use, the communication architecture, the communication procedures, and the types of network and protocol for each procedure Design decisions in each of these steps produce particular performance levels to which user behaviour can be measured User behaviour plus service tarifs then provide the basic data for business case analysis Each of the design decisions will now be briefly reviewed

3 1 Communication tasks

The communication tasks of the users of the market place fall under 8 headings Definition and distribution of new or updated product offer definitions, creation and distribution of multimedia information, creation and distribution of product availability and prices, negotiation of commisions/discounts/specific prices, searching for products, retrieval and viewing of multimedia, retrieval and viewing of availability and prices, and package creation and booking

3 2 Types of Information

These tasks are applied to 5 types of information product offer definitions, multimedia descriptions, booking information, negotiation information, information about the use of the market place The distribution of this information, between users, needs to follow the changing *patterns of trading*, in particular the current predominance of local/national and cross border trading, otherwise unnecessary communication and storage costs would be incurred Thus the consortium decided to implement a worldwide distributed system with local storage for each of the 5 information types, interconnected as a dedicated IP network The methods for the distribution and storage of the five types of information is as follows

Product offer definitions: This information is used to update the database, which then enables users to search for products Users should not need to know where data is stored in order to make a query, therefore for the user there should be one logical database where a particular query provides the same results regardless of where it is made This method implemented in SAM is to install servers (database local nodes) at each geographical location and to universally update each of them with each new product definition provided by the point-of-offer users This updating takes place whenever any point-of-offer decides to add or update a product definition

Multimedia descriptions: This information enables point-of-offer users to market and differentiate their products and may be requested by point-of-sale users after they have identified products from their initial search in order to obtain extra information It is unlikely that all point-of-sale users will require all multimedia information, in addition it is unlikely that points-of-offer will want to market their products to all points-of-sale Thus the location of multimedia information will be determined by the needs of the users The method implemented in SAM is to enable points-of-offer to distribute the multimedia associated with a product offer definition to particular locations, and to enable points-of-sale to easily retrieve the multimedia if they don t already have it The creation and distribution of multimedia is thus directly controlled by each point-of-offer and point-of-sale user

Booking information: This information covers availability and prices associated with the product offer definition, for example the prices and availability of various categories of room/seat/option Point-of-offer users wish to change availability and prices at any time, and point-of-sale users wish to book easily from up to date availability information and receive confirmation in real time This information changes continuously, is managed by each point-of-offer, and the communication flows follow the major trading patterns This method implemented in SAM is to keep booking information local to the particular point-of-offer who updates it and this is then accessed remotely from all interested points-of-sale.

Negotiation Information: This information is used to support the creation of more or less durable trading relationships. For example Point-of-offer will wish to alert particular customers of new offers and future products, and points-of-sale will wish to negotiate special prices, and commissions. This method implemented in SAM is to use a messaging system between SAM users.

Market Place Usage information: This information is used by points-of-offer to improve product marketing, and service providers to manage their regional networks. The system logs all events such as the viewing of multimedia information. For feedback to points-of-offer this information has to be collected from local nodes of the database, sorted and aggregated in terms of "product owner", and then made available to those product owners. This method designed in SAM is to sort the information at each local node by product owner, and to transfer this to the local nodes of each of the product owners, where it is aggregated and made available. This is done automatically but periodically rather than continuously. Regional service providers have access to a continuously updated record of the marketing and selling events in their region.

In addition point-of-offer users have a service which monitors the status of the universal updating of the market place with their products and of the distribution of their multimedia product descriptions. Point-of-sale users have a service which monitors incoming product information and multimedia descriptions.

The final design of the system requires that these methods of information distribution are matched to a communication architecture and detailed communication procedures and ptotocols.

3.3 Communication Architecture

The communication architecture for service provision is organised via a set of interconnected regional service providers (RSP) each of whom has connections to point-of-offer and point-of-sale clients as shown in Figure 1.

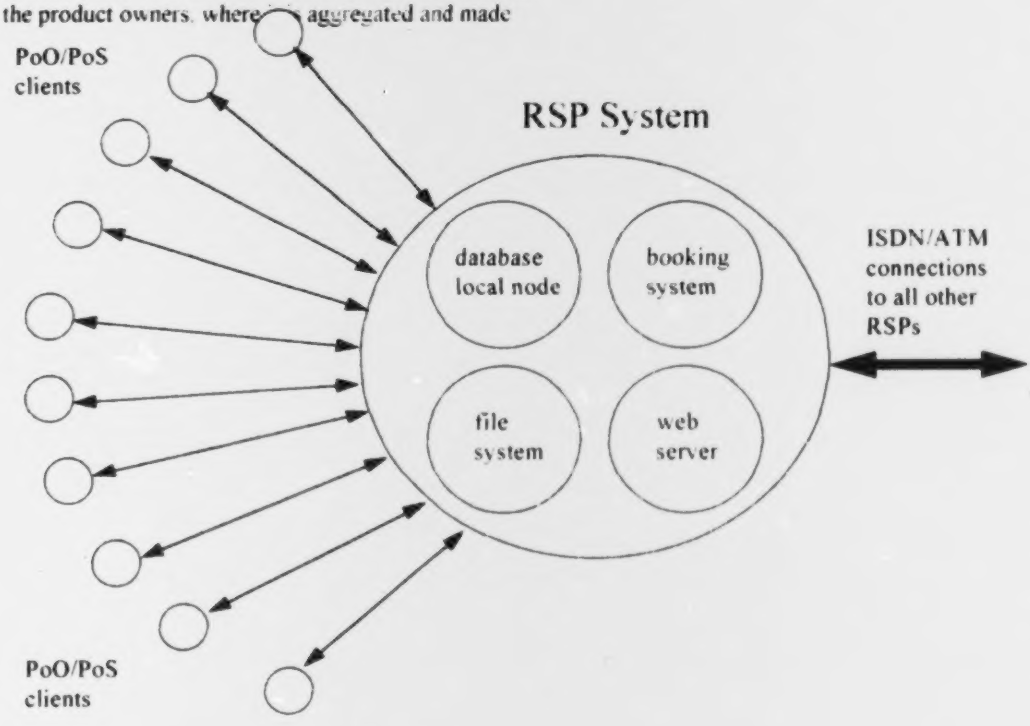


Figure 1. Regional Service Provider (RSP) System

The interconnection of the RSPs provides the international framework and is chosen to reduce the needed number of user to user connections and needed international transfers (If one user receives multimedia files then if there is storage of multimedia at regional level all the other users in that region will not require an international transfer)

3.4 Communication Procedures

For communication procedures let us take the example of the transfer of multimedia information A number of different procedures are being examined, individually or in combination These include Transfers of new multimedia that are "retrieval based", transfers that are distribution based (including distribution by request), updates to multimedia that are distribution based, updates to multimedia that are retrieval based, transfers that are executed in real time, transfers that are aggregated at the RSP node and made at cheap rate times

3.5 Communication Networks

For networks the project has examined, user-to-RSP connections of modem over analogue lines, ISDN and ATM, and Internet, and RSP-to-RSP connections of ISDN, and ATM Except for ATM these services have been switched and on-demand ATM was provided so that it appeared to the users as switched, on-demand, and variable bandwidth The ATM interconnections are shown in Figure 2

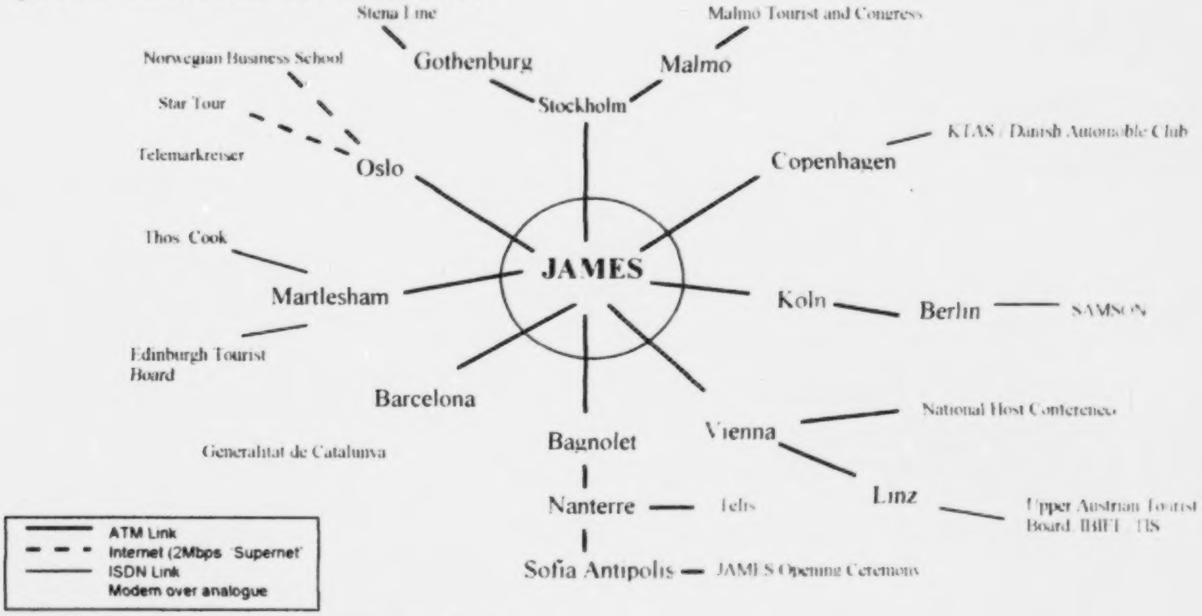

Stena Line
Malmo Tourist and Congress
Norwegian Business School
Gothenburg
Malmo
Star Tour
Stockholm
KTAS / Danish Automobile Club
Telemarkreiser
Oslo
Copenhagen
Thos Cook
JAMES
Martlesham
Koln
Berlin
SAMSON
Edinburgh Tourist Board
Barcelona
National Host Conference
Vienna
Generalitat de Catalunya
Bagnolet
Nanterre
Telis
Linz
Upper Austrian Tourist Board IBIFT TIS
Sofia Antipolis
JAMES Opening Ceremony
ATM Link
Internet (2Mbps 'Supernet'
ISDN Link
Modem over analogue

Figure 2 The ATM interconnections between RSPs

3.6 System Architecture and protocols

The SAM system is a PC/Windows based Client/Server system All *SAM Servers* are running NT Server with SQL-Server Database System The *SAM Clients* are running Windows 3.1, Windows 95 or Windows NT The architecture is built upon a *distributed multimedia database system* using the *TCP/IP protocol* standard for transferring information throughout a world-wide network The ODBC standard using the TCP/IP protocol, is used as the interface between the SAM applications and the SAM database The standard FTP protocol is used in the distribution/retrieval process for multimedia information A SAM-Server can also act as a SAM-Client, where the Server and Client are running on the same machine A SAM Client can be a *remote client* to the SAM Server The underlying network is transparent to the user, and can employ different network technologies, as long as TCP/IP is running on top

Figure 3 gives an overall idea of the main technical components of the SAM Clients and SAM Servers

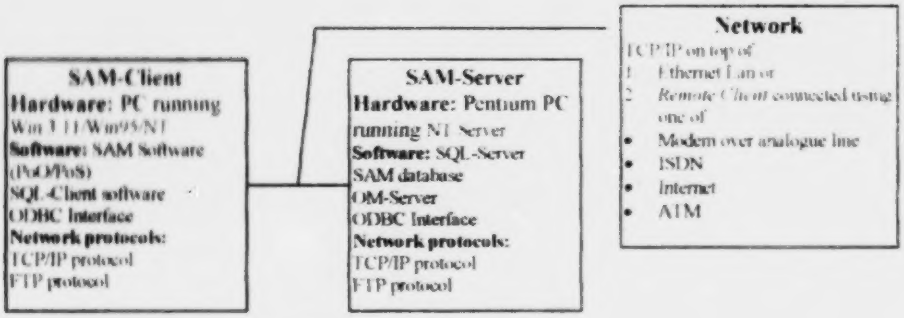

SAM-Client
Hardware: PC running
Win 3.11/Win95/NT
Software: SAM Software
(PoO/PoS)
SQL-Client software
ODBC Interface
Network protocols:
TCP/IP protocol
FTP protocol
SAM-Server
Hardware: Pentium PC
running NT Server
Software: SQL-Server
SAM database
OM-Server
ODBC Interface
Network protocols:
TCP/IP protocol
FTP protocol
Network
TCP/IP on top of
1 Ethernet Lan or
2 Remote Client connected using one of
Modem over analogue line
ISDN
Internet
ATM

Fig. 3 *SAM Client and SAM Server with software hardware, protocols and network*

A SAM Server can be a *SAM RSP Server*. An RSP Server handles one or more SAM-Clients, some are Server. A SAM-Client represents a PoO, a PoS or both. All SAM Clients are connected to one and only one RSP - which is defined in the system.

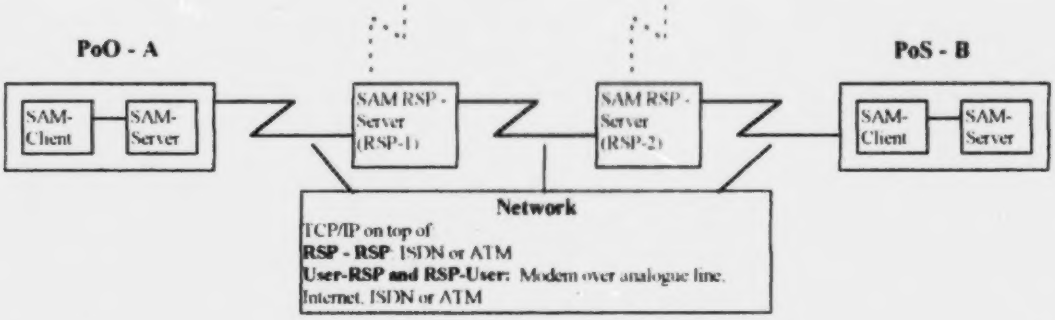

PoO - A
PoS - B
SAM-Client
SAM-Server
SAM RSP - Server (RSP-1)
SAM RSP - Server (RSP-2)
SAM-Client
SAM-Server
Network
TCP/IP on top of
RSP - RSP: ISDN or ATM
User-RSP and RSP-User: Modem over analogue line, Internet, ISDN or ATM

Fig. 4 - *A possible connection between two SAM users, both running their own SAM database*

Distribution of a folder with multimedia. The connection in Figure 4 is used as an example of what happens in the process of updating the SAM databases, or in the distribution/retrieval of multimedia information. In this example we assume that it is the first time PoO-A distributes the folder to the world wide network.

1. The PoO application (at PoO-A user site) sends a message (using *tcp ip packets*) to the local SAM-Server (OM-Server application) - about distribution multimedia from PoO-A to PoS-B
2. The OM Server sends the message to the connected RSP-1 Server (RSP-1) (User-RSP)
3. RSP-1 uses the message to update the database (using ODBC) with the product offer definition (local ODBC call)
4. RSP-1 executes FTP GET call: Receive Multimedia from SAM Server (in PoO-A) (RSP-User)
5. RSP-1 sends the message to RSP-2 (RSP-RSP)
6. RSP-2 uses the message to update the RSP database with the product offer definition (local ODBC call)
7. RSP-2 executes FTP GET call: Receive Multimedia from SAM RSP-1 Server (RSP - RSP)
8. RSP-2 sends the message to PoS-B (RSP-User)
9. PoS-B uses the message to update database with the product offer definition (local ODBC call)
10. PoS- 2 executes FTP GET call: Receive Multimedia from SAM RSP-2 Server (User- RSP)

Three different databases (RSP-1, RSP-2 and PoS-B) are updated the product offer definition, and all three SAM Servers also get the multimedia information. The PoS-B Client can choose to store the multimedia information locally.
Since the system uses the standard TCP/IP protocol, all kinds of underlying networks can be used. For example, the connection between PoO-A and RSP-1 could use Internet, the connection between RSP-1 and RSP-2 could use ATM, and the connection between RSP-2 and PoS-B could use ISDN.

Updating the databases with the product offer definition only. When a PoO has defined a product offer the whole network will *be universally updated* The process of updating can be described as above, there is however no need for the FTP-calls (points 4, 7 and 10)

Multimedia Retrieval A retrieval process is similar, there is however no need for *database update*, which is already done during the universal update process (see above)

If PoS-B wants to retrieve multimedia information connected to an offer defined in PoO-A, the following happens

1. The PoS-application in PoS-B sends a message to the OM-Server Retrieve multimedia information
2. The OM-Server checks if the multimedia is stored locally, if it is - the process finishes. If not
3. The message is sent to the OM-Server of RSP-2 If the multimedia information is stored in the RSP-2 Server, an FTP GET is executed and the multimedia is retrieved and stored at PoS-B. If not
4. The message is sent to the OM-Server of RSP-1 The same process as in 3 takes place
5. The message is sent to PoO-A if neccesary The same process as in 4 takes place

OM-Server The OM-Server application keeps track of all *distribution retrieval update* with respect to a particular SAM-Server In a large network with maybe 50 RSPs and more than 1000 PoO/PoS user sites, there will always be Servers or Network connections breaking down, Routers or Network Channels busy or applications not working properly The OM-Server application manages this by putting processes in a waiting state whenever they are impossible to execute at some particular time For example, in the process of distribution described above, the connection between RSP-1 and PoS-B (point 8) could be impossible to establish (e g all ISDN channels busy) In that case, the OM-Server of RSP-2 would put the message in a waiting state, and try to establish the connection later

Expected ATM performance

ATM is being used between some RSPs (see Figure 2) The infrastructure of the European ATM-network (supported financially by the European Commission) consists mainly of a 34 Mbit network connected with one or more ATM switches in each country The current signalling standard from client sites to the ATM switches is ATM Forum UNI 3 0 It is however, important to distinguish the signalling that is between the client workstation and the switch, from the type of signalling between switches (NNI signalling) No international standards exist for the NNI signalling yet, thus making wide area ATM LAN emulation and classical IP difficult In field trials, static VPI/VCRs were set up for the duration of the operation of the network ATM is designed to support high capacity simultaneous transmit and receive since the channel itself is unidirectional Each connection consists of two connections that can operate on full speed, one connection for each direction The problem of simultaneous transmit and receive is primarily a problem related to the host computer When data is moved to and from any high speed network adapter, the individual streams compete for shared resources That is for instance the I/O bus (e g the PCI bus), the DMA controller, the CPU bus and memory Many first and second generation ATM cards show a significant performance degradation when more than one or a few simultaneous connections are active at the same time ATM card vendors tend to specify their network interface cards as "workstation" or "server" type, meaning that the "server" cards have been optimised for many simultaneous channels This should be taken into consideration for further planning of the SAM system A high end PC (a PCI-based PC running NT on a Pentium > 150 MHz or Pentium Pro) can easily sustain throughput of more than 34 Mbit/s, and thus exhausting the channel capacity if only one channel is to be serviced As soon as more channels are required the number of simultaneous channels that can be effectively supported is vendor-dependent Some vendors have SAR chips (Segmentation and Reassembly) that effectively can support multiple simultaneous streams, and even perform traffic shaping as required by the ATM network Other vendors can support many channels, but only at a "best effort" principle, often without traffic shaping

It is also important to distinguish between memory-to-memory throughput and disk-to-memory and disk-to-disk throughput The performance of the disksystem can easily be a limiting factor when many simultaneous transfers are active If the files are laid out without taking the streaming problems seriously, the disk may easily get into a trashing state where it spends most of its time seeking and can not sustain the bus throughput for which the disk is purchased (typically 4-15 MB/second/disk) This throughput can never be reached if not elaborate disk striping and disk driver scheduling techniques are employed Many RAID systems use disk striping As it is implemented in the prototype, all the multimedia is transferred from disk to disk -and the system is not properly exploiting the real-time access over the WAN - ATM network

3 7 Performance monitoring

Collection of usage data in the trials is highly systematic and automated This is important from two points of view First, it has enabled detailed and valid findings and conclusions to be drawn from research and testing, which has been vital in the process of fine-tuning both applications and communications procedures. Second, and perhaps most important, data on the communications tasks and information types mentioned in section 3.0, and captured at all user terminals, enables careful tracking of commercial performance at four levels production of marketing material, communications, viewing/browsing, and sales/reservations. *Table 1* lists the events automatically logged. Each event is identified by site, user, folder, insert or transaction using unique ID numbers.

open session PoO	display package***
open session PoS	create package
close session	modify package
display folder*	searching for package
create folder	close package
modify folder	open reservation PoO
view by map searching for folder	open reservation PoS
view by offer searching for folder	close reservation
close folder	outcoming distribution information
display insert**	outcoming distribution information + MultiMedia files
create insert	incoming distribution information
modify insert	incoming distribution information + MultiMedia files
close insert	file remote retrieval

* A folder is the concept for the container of the multimedia product description

** The content of the folder is composed of inserts

*** A package is a multiproduct multi vendor itinery, constructed for a specific customer from the products available on the market place, each element of which can be booked in real time

Capturing data is only the first stage in analysing user and commercial performance. A set of information handling tools has also been developed as part of the SAM system. These calculate and present transfer times and allow the progress of folders or reservations to be traced across the SAM system. These performance data can be presented in any chosen way - by site, terminal, user, or sales person, for example, and then analysed using a set of spread sheet based procedures for the business cases. This data is used for questions such as: What is the ratio of browsing through folders to numbers of bookings? How many transactions are typically handled per day by Regional Service Providers? How many times per month are folders updated by Points of Offer? How often do Points of Sale retrieve multimedia information? What is the average size of multimedia retrievals at Points of Sale?

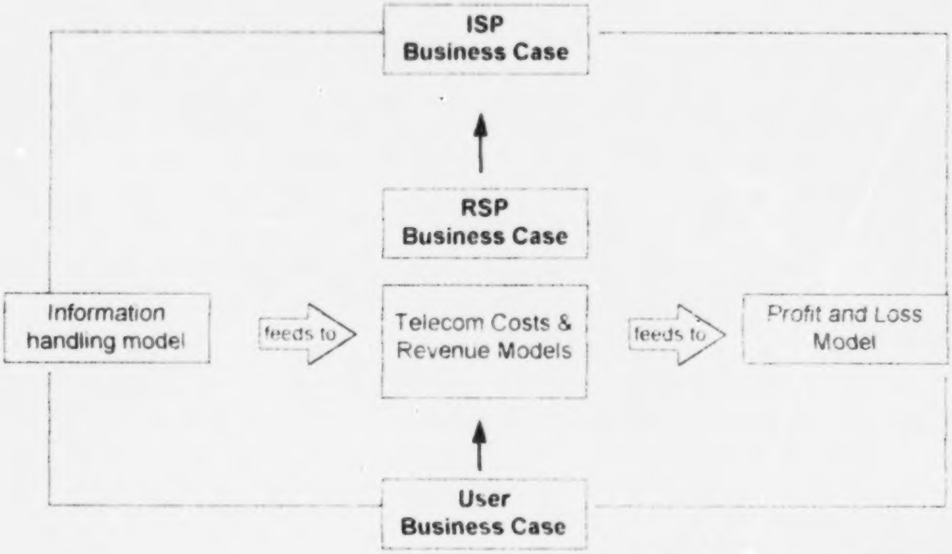
4.0 Business Cases based upon Telecommunication Options

It is clear that the economics of any distributed database and transaction service are complex. Any start-up or new business, particularly one based on novel technology, has to calculate likely levels of demand and to provide an adequate level of resource to provide satisfactory standards of service. If the forecast is too pessimistic the business will quickly attract criticism for poor service (this has happened to many Internet service providers), but if it is too optimistic payback will be delayed and the return on investment will be lowered. For SAM this problem of dimensioning occurs at many levels and in many places, particularly if network purchase and provisioning is decentralised. On this model, the RSP needs to dimension the service provided very carefully, having regard to: Local telecommunications services and their tariffs, the availability and technical maturity of local equipment supply, maintenance and installation services, the types of information that local vendors of holiday products wish to use as a marketing tool over SAM, the kinds of holiday product that local points-of-sale wish to source and the extent to which they can store all high bandwidth material on their local site, or require real-time access over regional, national or international links, and the geographical patterns of trading that local customers are likely to develop. There will be some hotel vendor-to-travel agency links that operate only in a region, involving a single RSP, whereas international linkages, for outbound or inbound tourism, will involve multiple RSPs.

4.1 The trials

The business case for SAM comprises three separate but interlinked models for ISP(International Service Provider -the coordinatingl management company), RSPs(Regional Service Providers - the operational companies), and Users (Points-of-offer, and points-of-sale) For each of these a profit and loss and cashflow forecast has been made based upon sets of common and specific assumptions Interlinking of the models means that it has been possible to find a set of sensible and tested assumptions that produce satisfactory outcomes for each of them

The following figure illustrates the structure of the business case model



The model for RSPs comprises four linked components An information handling model for the RSP which shows how varying patterns of information retrieval and distribution, locally and internationally, impact the dimensioning of computer and communication facilities, thus providing a basis for calculating required fixed investments, A telecom costs model that translates information flows into costs by feeding these into tariff tables; A revenue model that calculates revenues obtained from PoOs and PoSs on the basis of subscriptions, storage charges, information handling charges and a commission on sales, A profit and loss model which takes assumptions about tariffs, traffic volumes and fixed investments, fixed and variable costs of operation, then calculates profit-and-loss, cash flow and return-on-investment

The business case requires values for The cost of computers and routers/modems for each telecommunications option (which determines the number of simultaneous calls/sessions that a single router can handle. Average length of call or session (10-40 seconds for a 1 Mbyte file transmitted at data rates up to 1 Mbs, 100-200 seconds if is sent by basic rate ISDN). Assumed frequency of distributions and retrievals, and the duration of the busy hour And projections for The number of customers, Point-of-Sale or Point-of-Offer, which are served by the RSP, Frequency of file distribution and retrieval, International ATM tariffs. The number and price of holidays sold at Points of Sale.

From these values and projections an RSP operation can start from a cost as low as $300,000 per annum, a sum which pays for a small office, several staff and several personal computers with some ISDN and ATM networking capability Their revenue is generated from commission on sales and from charges for storage of multimedia This can generate about $1200 of annual revenue from each advertiser and puts the break-even number of PoO and PoS accounts at about 450, for a set of assumptions about usage patterns

The dependency of the business case on network type was analysed with respect to the growth in the number of RSPs and the number of clients of each RSP Five cases of ATM tarifs for 2mbs connection ((a)500, (b)550, (c)900, (d)1500, (e)2800 ECUmonthly rental) were compared to ISDN and Frame Relay (fr) and an ATM connectionless service (atm*) The yearly telecom costs from 1997 to 2006 in MECU were

	97	98	99	00	01	02	03	04	05	06
isdn	0.3	0.5	0.8	1.0	1.1	1.2	1.3	1.3	1.4	1.4
atm	0.1	0.2	0.2	0.3	0.3	0.4	0.4	0.4	0.4	0.4

fr	0.7	1.2	1.7	2.1	2.4	2.7	2.8	2.9	3.0	3.0
a	0.2	0.4	0.5	0.7	0.8	0.8	0.9	0.9	0.9	0.9
b	0.2	0.4	0.6	0.7	0.8	0.9	0.9	1.0	1.0	1.0
c	0.4	0.7	1.0	1.2	1.4	1.5	1.6	1.7	1.7	1.7
d	0.7	1.2	1.6	2.0	2.4	2.6	2.7	2.8	2.9	2.9
e	1.3	2.2	3.2	4.0	4.5	5.0	5.2	5.4	5.5	5.6

The table shows that considerable economic benefits can be obtained from ATM if the rental is about 500 ECU per month and that services which do not depend upon a large number of fixed links e g a connectionless service are much cheaper as the size of the market place grows.

4 2 The trials technical and user evaluation

The trials began in July 1996 and will continue until July 1997 During this period the international networks between 25 countries are ISDN and/or ATM There was a concentrated ATM trial between 9 european countries during September-October 1996, which was supported by the European Commission as part of the Trans European Network Programme The international networks were provided by the JAMES project (A consortium of the European network operators)

Datalogging at terminals proved to be useful, in that it proved possible to trace the progress of mutimedia transmissions across the network, and to assess the amount and type of work that users were able to get through in a fixed period of time

Between some sites lower ATM throughput was achieved than expected - 1Mbps compared with the 2 4 Mbps provided Reasons for this included using IP over ATM, LAN to LAN connection rather than ATM server to server; and the overheads that seem to be incurred when going through many switches On one site there was a direct ATM link to the server, and throughput of 1 5 rather than 1 Mbps was achieved This suggests that access to ATM via Ethernet-based LANs can significantly reduce performance, particularly if there is other heavy traffic on the LAN.

A number of lessons were drawn about routing - in particular that static routing should be avoided in future configurations At the moment routers have to be configured manually, and every site has to be sent an updated version of the database each time an IP number is changed The feedback and assessment procedures used allowed solutions to other small but irritating problems Time-out of ISDN routers, for example, led to unacceptable queuing times That these and other issues were able to be discovered and solved points to the importance not only of controlled trials but of having carefully planned monitoring procedures in place

In conclusion, the trial demonstrated conclusively from technical, user and business points of view that a future ATM commercially offered service for the SAM application should be connectionless Static VPI/VCRs had been set up for the duration of the trial, but a working SAM network based on ATM will require both immediacy and flexibility It must be possible in the future to access selected remote locations for multimedia transmission at times the customer chooses, and of course without having to book lines the day or week before The business cases suggest that if these basic criteria are met, together with a tariff regime partly based on usage and bearing sensible comparison to other broadband services, then SAM could be a significant worldwide ATM customer

Glossary

SAM - Services and applications for a world wide market place in tourism
ISDN - Integrated services digital network
ATM - Asynchronous transfer mode
RSP - Regional Service Provider
ISP - International Service Provider
ODBC - Open database connection
FTP - File transfer protocol
TCP/IP - Transport protocol/Internet protocol
DMA - Direct memory access
CPU - Central processing unit
WAN - Wide area network
LAN - local area network
ECU - European Currency Unit
VPI - Virtual path identifier
VCI - Virtual channel identifier

An ATM switching system supporting POTS and FR service
- Design concepts and architecture -

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ABSTRACT This paper describes the design concept, system architecture, and test result of an IWS(InterWorking subsystem) which accommodates the existing POTS(Plain Old Telephone Service) and the FRS(Frame Relay Service). The proposed system architecture has flexibility to accommodate other types of interworking function by substituting network interface part while keeping the whole system architecture. We verified the PSTN subscriber interworking functions by connecting the PSTN subscribers via the ATM switch and performing voice communication.

1. Introduction

Early ATM implementation serves as backbone networks mainly for data communications. Therefore existing or upcoming data services, such as X.25, frame relay, and SMDS(Switched Multi-megabit Data Service) have to be supported[1].

Frame relay is an enhanced packet-type service. Higher throughputs and less delay are achieved by reducing error control and forgoing end-to-end flow control. Frame relay is a connection-oriented service offering bit rates of from some Kbit/s up to 2 Mbit/s or possibly higher[8][10][11]. SMDS was introduced by Bellcore as a high-speed, connectionless packet-type data service at bit rate up to 45 Mbit/s and, subsequently 155 Mbit/s.

Another service to be offered initially to customers is the constant bit rate leased line service(circuit emulation). As in the case of frame relay and SMDS, such a leased line service can, of course, also be provided by conventional networks. The merit of an ATM backbone network for the network operator is that a common network can be deployed flexibly to support all the existing and future services. New switching systems are thus needed to handle not only new ATM-based services but also existing services, such as POTS, N-ISDN(Narrowband Integrated Services Digital Network) services and FRS. Recently with these trends, the concept of VTOA(Voice and Telephony Over ATM) has been actively discussed[2][3][4][5].

This paper describes the design concept, system architecture, and the test result of the IWS which accommodates the existing POTS and FRS in an ATM switching system.

The content of this paper is organized as follows. In section 2, we first describe the overall system configurations for accommodating PSTN subscribers and FRS over ATM networks. In section 3, we describe newly designed function modules. In section 4, we show some test results for call processing. Finally, we summarize the result of this work and suggest some future research issues in section 5.

2. System overview

2.1 Design Considerations

A. PSTN interworking

The IWS should have a well-defined modular structure to minimize the effect on whole system architecture. IWS provides access interfaces to existing networks and internal link interface to cell based ATM switch fabric. In order to maximize the utilization of accumulated STM(Synchronous Transfer Mode) technologies and well-proved system stability, it is better way to use existing STM products currently in service and develop additional CLAD(Cell Assembly and Disassembly) function module which is located at the intermediate stage between STM time-switch and ATM switch fabric. To minimize extra product cost for providing additional PSTN interfaces, CLAD function is integrated into a centralized module which handles multi connections at the same time. Another design viewpoint is that by implementing CLAD function to have a STM time-switch interface, it could be utilized for other types of network interworking, for instance, N-ISDN or CCS7 etc, just by substituting interface module. This is because most of STM access switching system has Time-Space-Time switch structure.

B. FR interworking

In our country, frame relay and ATM get ready to start commercial service. Our ATM switching system needs frame relay interworking function immediately. And service interworking is more urgent than network interworking because of our frame relay market. ATM and frame relay target to enlarge their services into existing leased line customers and private network users simultaneously. It is expected to require ATM-to-frame relay service interworking in data communication. The need of providing frame relay SVC(Switched Virtual Connection) is another reason for service interworking. Our frame relay network providers have plans to offer SVC by the end of this year.

The design concept of frame relay interworking module is to persist the same hardware architecture of the DS1/E1 interface module. So the module consists of a little common function and lots of subscriber boards. The subscriber board with HDLC and ALL5 controller supports channelized frame relay service interworking function. Incoming signaling message is not processed here but transferred to call control processor by IPC message.

2.2 System Architecture

Figure 1 shows the configuration of ATM switching system including IWS for PSTN subscriber and FRS access. ATM Switching System basically consists of 3 subsystems, that is, ALS(ATM Local Switching Subsystem), ACS(ATM Central Switching Subsystem) and IWS. ALS provides interfaces for ATM UNI(User Network Interface) and NNI(Network Node Interface) with different bit rates(DS1E, DS3, STM-1, STM-4). ALS has its own control processor, CCCP(Call and Connection Control Processor), which handles overall call control and maintenance function within ALS. ACS is a kind of distribution network which provides communication path between ALSs via ISNM(Interconnection Switch Network Module)[7].

The IWS handles interworking function. IWS provides versatile interfaces with existing networks including POTS, N-ISDN subscribers and FRS. The interworking call control function for service interworking resides at CCCP in the ALS which IWS belongs to. IMI(Inter Module Interface) is a internal link interface used for interconnecting switch module(ISNM or ASNM) and the other modules. The internal cell format on the IMI consists of 3 octets routing tags and 53 octets ATM cell.

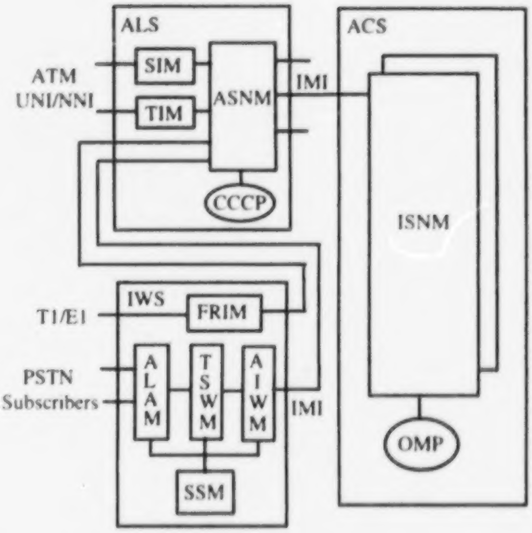
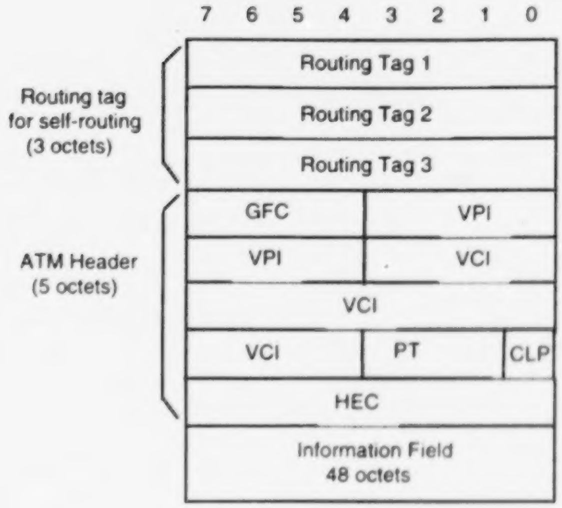
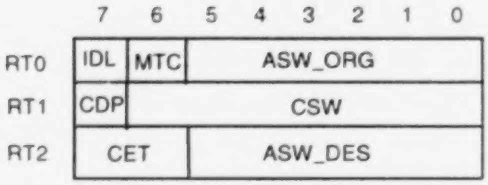


Figure 1 The configuration of ATM Switching System

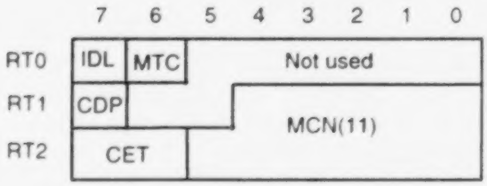
The routing tags are used for self routing through 3-stage switch fabric. The Internal cell format is shown in figure 2. IWS consists of ALAM(Analog Line Access Module),



(a) ATM Cell Structure



(b) p-t-p



(c) p-t-mp

IDL : Idle cell ID(0:Busy, 1:Idle)
MTC : Multicast cell(0:p-t-p, 1:p-t-mp)
CDP : Cell.Delay Priority ID
CET : Cell type ID(00:User information cell, 01, 10: Controller cell, 11: IPC cell)
ASW_ORG : Access Switch Origin address
CSW : Central Switch physical address
ASW_DES : Access Switch Destination address
MCN : Multicasting Channel Number
p-t-p : Point-to-Point
p-t-mp : Point-to-Multipoint

Figure 2 Internal Cell Format

TSWM(Time SWitch Module), SSM(Signalling Service Module), AASM(Analog Access Switching Module), FRIM(Frame Relay Inter working Module) and AIWM(ATM InterWorking Module).

ALAM provides analog subscriber interface and performs BORSCHT(Battery feed, Over voltage protection, Ringing, Supervision, Code/decode, Hybrid, and Test access) function. TSWM is a STM-based time switch which performs time-slot exchange, A/u-law conversion and concentration. SSM is composed of Ring Generator, Conference Mixer, Voice Message Handler in order to provide the several service features. AASM is composed of several software blocks performing interworking function between analog subscriber and ATM subscriber. AIWM is located between PSTN interface part and ATM Switch. AIWM performs AAL Type 1[6] for user information and AAL Type 5[6] for IPC(InterProcessor Communication) messages. FRIM supports all frame relay interworking functions but not call control signaling. Call control signaling including Q.933-to-Q.2933[9] mapping are supported by CCCP which is common call control processor. By the way, call control signaling message accepted by FRIM is transferred to CCCP with IPC format.

2.3 IWS capacity

An IWS accommodates 8,192 PSTN subscribers when 1,024 time slots are used with the concentration ratio of 8:1. The CLAD circuit performs cell assembly and disassembly function over 1,024 connections(channels) simultaneously. FRIM has 64 DS1/E1 interfaces. The multiplexed traffic of 64 E1 interface is 128Mbps. Each E1 has 31 channels of 64kbps in channelized frame relay. We assign 16 kbps to minimum CIR(committed information rate) for PVC(Permanent Virtual Connection)[12]. This means that a FRIM accommodates maximum 7936 (64x31x4) connections. But the number may be reduced to some reasonable amount like 4096. The number depends on user traffics. The user traffic trends are getting wide in accordance with diverse multimedia services. On the other hand, 1024 connections is regarded reasonable for STM1 ATM UNI. In the same point of view, we guess that 1024 connections in our FRIM may be enough for some time.

3. Newly designed function modules

3.1 AIWM structure

The main function of AIWM is data format conversion between STM and ATM. AIWM is mainly composed of CADA(Cell Assembly and Disassembly Assembly), ASIA(ATM Switch Interface Assembly), IWCA(InterWorking Control Assembly) and PCGA(PSTN Clock Generation Assembly) as shown in Figure 3. CADA performs AAL 1 CLAD function for individual connection identified by time-positioned number(time slot) in STM-side and by virtual connection identifier(VPI/VCI) in ATM-side. All control data relating indication of connection establishment and release, routing tag and ATM header value and AAL1 operational parameters are given by IWCA. CADA supports additional features for AAL1 such as multi-bit rate(nx64 Kbps) and partially-filled cell structure. ASIA performs cell multiplex and demultiplex function. ASIA distributes received cells from IMI link to IWCA or CADA depending on the cell type indication of routing field.

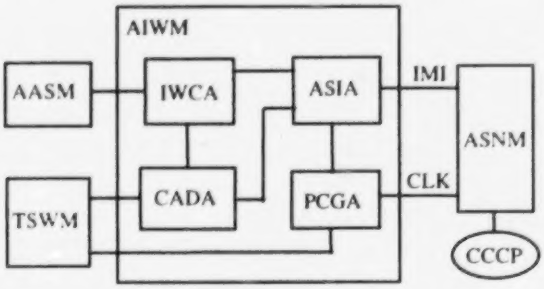


Figure 3 AIWM Structure

The possible cell types are IPC, USER and IDLE cell. In the reverse direction, user cells from CADA and IPC cells from IWCA are multiplexed according to priority-based scheduling scheme and sent to IMI link by ASIA. IWCA controls CADA and ASIA. Another function of IWCA is inter-processor communication with AASM via global bus interface. The IPC messages generated by AASM are segmented into ATM cells of AAL Type 5, and in the reverse direction the non-user ATM cells from the ASNM are reassembled at IWCA via ASIA. PCGA receives system clock from ASNM in ALS and generates reference clocks for STM part, that is, 8 K Frame Sync and 16.384 MHz clock. Also, PCGA provides IMI clock to ASIA. For reliability, AIWM is fully duplicated.

3.2 FRIM structure

FRIM consists of FMDA(Frame Relay Mux/demux Assembly), FCDA(Frame Relay Clock Distribution Assembly) and 16 FRSAs(Frame Relay Subscriber Assembly) as shown in Figure 4. FMDA, IPC main processor in the module, performs ATM cell mux/demux. It is connected to ASNM in ALS by IMI. FCDA performs clock distribution function. It receives system clock and generates intra-module clocks. FRSA performs frame relay interworking core function. It has 4 DS1/E1 interfaces, 4 32-channel HDLC controllers, AAL5 controller, bus arbitrator and interrupt handler. In data communication, FRSA receives HDLC frames and converts the frames to AAL5 ATM cells and transfers the ATM cells to FMDA by parallel bus with 56 byte cell format. Frames with DLCI=0 are transferred to IPC cells. These IPC cells and other IPC data are transferred to FMDA through control bus.

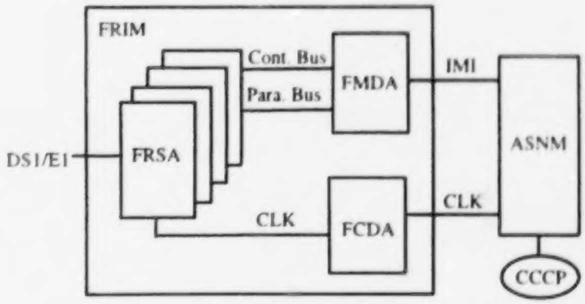


Figure 4 FRIM Structure

4. Test results

We are designing software supporting Q.2931 signal mapping function for call control between PSTN subscribers and ATM subscribers. However, we need to confirm the designed IWS hardware functions as soon as possible. Figure 5 shows the configuration of call processing test between PSTN subscribers and PSTN subscribers via ALS. For this test we modified the IPC message formats transferring between the AASP in the AASM and the IWP in the AIWM. And we added a look-up table converting the time slot number in STM side versus the VPI/VCI in ATM side. The test shows that the PSTN interworking function is performed successfully.

5. Conclusion

This paper has proposed an ATM Switching System architecture which accommodates the existing POTS and the FRS. The proposed system architecture has flexibility to accommodate other types of interworking function by substituting network interface part while keeping the whole system architecture. Also, we verified the PSTN subscriber interworking functions by connecting the PSTN subscribers via the ATM switch and demonstrated both voice communication and data transfer simultaneously. And we have designed the FRIM supporting channelized frame relay service interworking function. Subsequently, the FR interworking function including Q.933-to-Q.2933 mapping will be designed and the PSTN interworking function including Q.2931 mapping will be verified by the end of this year.

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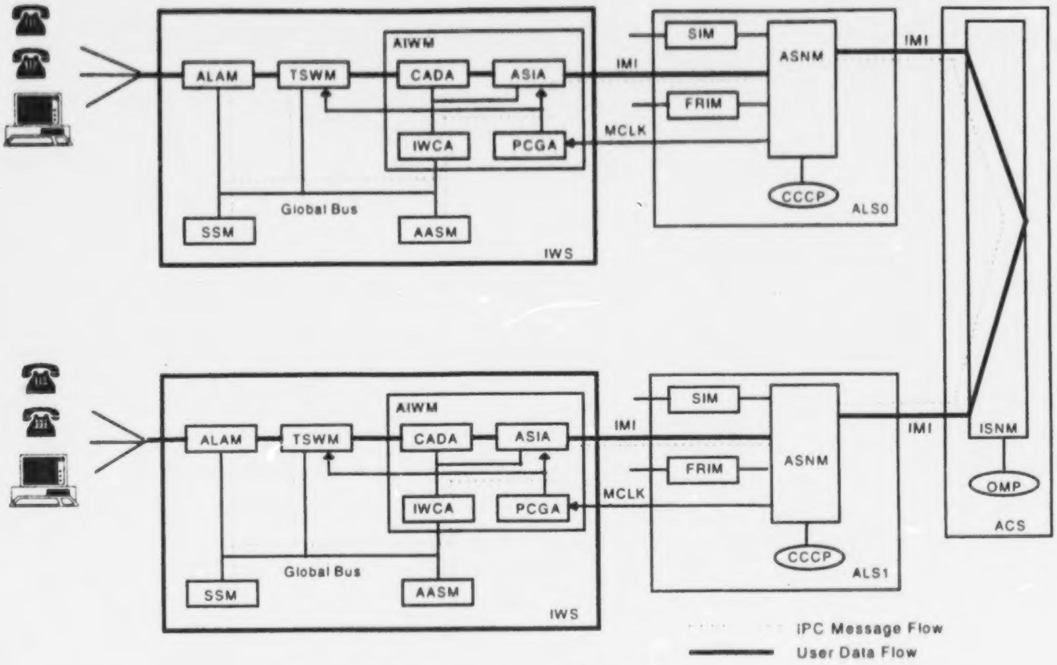
AIWM
ALAM
TSWM
CADA
ASIA
IWCA
PCGA
Global Bus
SSM
AASM
IWS
IMI
MCLK
SIM
FRIM
ASNM
CCCP
ALS0
ALS1
ISNM
OMP
ACS
IPC Message Flow
User Data Flow

Figure 5 The configuration of call processing test

Broadband Satellite Networks and the Challenges for Their Full Inclusion in the Global Information Infrastructure

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1. ABSTRACT

In the last decade, communication satellite technologies have advanced rapidly to the point where a large number of commercial Ka-band broadband satellite networks will be deployed in the near future. These networks demonstrate the ability of communication satellites to provide broadband services in any part of the world, to complement the terrestrial networks. Also, the concept of GII has been emerging and satellites can provide superior service to GII if they form seamlessly interoperable network of networks. In this paper, we describe the challenges as well as approaches needed to achieve seamless interoperability of satellite and terrestrial networks. We also discuss, what advances in technologies are needed to maintain the role of satellite networks in the GII.

2. SATELLITE NETWORKS AND THE EMERGING INFORMATION INFRASTRUCTURE

The concept of the Global Information Infrastructure (GII) (1) as a worldwide "network of networks" that will create a global information marketplace, encouraging broad based social discourse within and among all countries. The GII is creating an information explosion that is producing ever increasing demands on all communications systems. A complex hybrid satellite and terrestrial systems together will form the GII. They will complement and be interoperable seamlessly with terrestrial networks (2). A wide variety of satellite designs and functions will fill many GII roles. Satellites as an essential element of the GII will enable communications services that would not be otherwise affordable or possible with other systems. However, implementation of broadband satellite networks in the GII faces many challenges. The service demand driven by the GII could rapidly out pace transmission technology capabilities. The focus then will be on the technology issues. Thus, hybrid satellite and terrestrial systems together will form the GII.

The GII will both stimulate and respond to global demand for new information technologies and services. Future satellite communications systems will be an essential and critical element of the GII because of its many unique advantages such as ubiquitous coverage (connectivity to everyone, everywhere), wide area high speed multipoint network, cost not distance dependent, allows user mobility, immune to natural disasters, permits simultaneous distribution of information to numerous users, enables rapid development and global interconnectivity of communications network at low cost, and provide aeronautical and maritime mobile communications services of voice, video and data. To complement a complex global hybrid network system, enable new services, and help build the GII vision and support its principles, satellites must overcome the following challenges (3, 4): spectrum allocation, standards and protocols, launch vehicle cost, seamless interoperability, advanced technologies, and international cooperation.

Broadband satellite networks in the LEO, MEO and GEO orbits operating primarily in Ka-band frequencies have filed applications for spectrum allocations to the FCC (5, 6, 7). Some systems will start operating as early as 1998. This is indicative of increasing user demand for broadband services worldwide and the ability of satellite networks to respond quickly to this growing demand. These networks will enable new services that are not otherwise affordable or possible by terrestrial communications systems. They will be interoperable with terrestrial components of the NII and GII. Satellite systems will be flexible to the user needs, providing bandwidth capacity available on demand. They will be reconfigurable to meet new and changing requirements, and provide switched services to directly interconnect users. A wide variety of satellite systems, designs and functions will fill specific GII roles in a seamless manner. These new GEO, LEO, and MEO systems together will be essential in providing one important aspect of the GII: "universal service." The goal is to provide access and affordable service to all members of society. Universal service is one of the most important principles of the GII vision. More than two-thirds of the earth's population do not have access to wired terrestrial communications services. First the infrastructure does not exist to support installation of wired services. Second, in today's global market it would be prohibitively expensive to try to provide fiber or wire services to this segment of the population. Satellite constellations of the types being proposed will enable all kinds of services to be brought to this very large section of the population.

3. INTEROPERABILITY AND TECHNOLOGY CHALLENGES

The success of the GII requires that all communications systems operate seamlessly. This makes interoperability one of the critical issues for hybrid network systems. There are inherent intrinsic differences between fiber optic and satellite links in bit error rate (BER), channel capacity and delay. These differences in communications links require that standards and protocols be designed to function over the different networks. However, currently some of the more widely used protocols such as TCP/IP or ATM are not very efficient over satellite links and require modifications(8). ATM, for example, was developed for high speed multimedia traffic over fiber optic links. ATM networks expect fiber-like quality from the satellite link. ATM propagation over a satellite link is not very efficient without modifications to the ATM protocol or the satellite link or both (8). Attention must be given to developing applications, new architectures and technologies, new standard and protocols, that will meet the challenge to work efficiently over different communications links that includes delay, asymmetrical channel capacity, and different bit error rates. These new architectures and protocols must at the same time provide efficient seamless integration of satellite and terrestrial networks.

Advances in specific technology areas are required for future satellite networks to stay competitive and compatible with various transmission media and to achieve the required seamless integration. The advances will be toward making them more flexible to meet future user needs and to operate on congested orbits and overcrowded frequency bands. Satellites have needs for advances in technology in the areas of advanced antenna power and advanced on board processing. On board processing will have to be low power, high speed, and capable to switch, multiplex and demultiplex more than 100,000 circuits into the satellite backbone network or users on the ground. Another key area is phased array antenna technology. Future antennas will have to be carefully designed to minimize side lobes to avoid interference with closely space satellites and also with wireless communications on the ground.

The technology that may offer most promise for satellite communications is probably free space optical communications (9). The first use will be for intersatellite links (ISL) and later for uplink and downlink. Optical communications has the potential to make satellites systems very compatible with future terrestrial networks. Currently there is a data rate capacity "choke pint" between satellites and fiber optics networks. Free space optical communication offers the potential to solve this data rate "choke point." Currently fiber optics backbone networks already exist running at several gigabits and this data rate will go up in the future. Satellite constellations will certainly have its own high speed backbone network in the future. However, the data rates will have to be compatible with fiber optics for them to be competitive, and for data to be transferred back and forth as will be required in many applications and circumstance. There are many potential technological solutions that could help overcome this data capacity "choke point," with optical communications being the most promising. In free space optical communication the data rate capacity is theoretically the same of the fiber optics network, because of the use of the same optical frequency carrier.

4. CONCLUSIONS

For GII services, broadband satellite networks will form one of the important elements, and in other services they may be most cost effective. These satellite networks will offer added capability in services to support GII principles of universal services, open access and promote competition. Clearly seamless integration of terrestrial and satellite networks is key to enable the GII vision in a timely and affordable manner and will require technical and regulatory solutions to several of the issues mentioned in the paper. Furthermore, to achieve the full potential of the future GII, efforts and strong partnerships among industry, governments and academia are needed. The GII can be a successful, shared global vision with participation and cooperation at an international level.

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The Collapse of the International Accounting Rates System and Rise of Cost-Based Global Telephony

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ABSTRACT

Accounting rates between countries are toppling worldwide like a row of dominoes. Excessive regulation, exorbitant monopoly rates and outmoded bilateral agreements historically have blocked network expansion and economic growth throughout the developing world. The driving forces of competition and the advances of low cost, high speed telecom technology are sweeping away these barriers—moving artificially high telephony rates closer to the real costs of terminating traffic. Alternative telecom methodologies—such as reorigination, private line resale, and refiling—allow aggressive telecom organizations to circumvent the existing accounting rates system, thereby exerting a downward pressure upon it. The result of these changing dynamics in global telephony will be improved service and lower costs for customers around the world, and a boost to the economies of Pacific Rim countries.

Telecommunications has been evolving at an extraordinary pace, as the convergence of computer and telephony applications hurtles forward. Fiber optic highways crisscross the globe, with cables traversing ocean floors and spreading across vast continents like a new generation of digital pioneers. Before the turn of the century, these fiber highways and a galaxy of new satellites will enable users to communicate with anyone, anytime, anywhere—and for the most part, at little or no cost. As Andy Grove, president and CEO of Intel, stated in 1994, we are rapidly approaching the era of free MIPS and free baud.

Yet while the actual technology of providing telecom service continues to evolve non-stop, the regulatory framework which governs the application and cost of such technology lags far behind. In fact, one might persuasively argue that the primary barriers obstructing society's realization of digital nirvana are simply outdated regulatory structures—such as the accounting rates regime—which prevent individual consumers, businesses, and the global economy from reaping the full benefits of technology's near-miraculous advances.

From the early days of the digital revolution, computer trade journals have consistently featured a plethora of articles and advertisements trumpeting the availability of increased processing power, speed and functionality—all at a substantially reduced price per feature or computing unit vis-à-vis prior generations of software and computer hardware.

In contrast, those who read telecom trade journals know that to this day, a majority of articles still concern governmental issues, such as applications for licensing of service, or motions filed with regulatory authorities. This is the inevitable result of individual operators jockeying for position, seeking to use governmental power either to defend their entrenched position, or displace an incumbent operator.

Few will deny that the computer industry's phenomenal growth over the past 40 years has occurred in an environment largely devoid of government interference and regulation. In fact, it is difficult to imagine that industry's explosive growth ever having occurred, had it been subject to the same competitive restrictions as the global telecom industry.

Perhaps most interesting, from a telephony perspective, is the fact that the unfettered growth of the computer industry has provided many of the fundamental technological building blocks responsible for telecom's enormous progress over the past twenty years. These include the development of digital switching, intelligent network platforms, and the complex billing and database architectures used by advanced operators throughout the world today.

And just as the rapid pace of technological development threatens inefficient or complacent computer industry titans with obsolescence (with new market entrants achieving prominence in just a few months or years through the introduction of superior technology), so too the staid world of telecom monopolies is poised for radical change, as the convergence of computers and telephony coincides with tumbling regulatory barriers in key markets worldwide.

The New Market-Driven Paradigm

The early liberalization of the U.S. and UK long distance markets has fostered a new breed of competitive telco—lean , hungry, and eager to exploit economic inefficiencies caused by the historical monopoly regulation of the telecoms industry. In recent years, new market entrants in virtually every corner of the world have utilized alternative calling procedures to secure entree to previously closed, monopolistic markets—leveraging technology and free market principles to compete with legacy carriers.

Callback, the most publicized of numerous alternative calling procedures, is one such "killer application." Enormous customer demand for callback has been fueled by high PTT collection rates; the absence of PTT discounts for large volume customers; often poor PTT customer service/relations; the widespread lack of fundamental billing features and enhanced services; and the general absence of competition in markets historically dominated by a single PTT/PTO.

Unlike traditional telecom services, which require an extensive network of switches and facilities, callback functions like a shotgun: from a single switch in the US or UK, callback companies have been able to penetrate markets and secure customers worldwide—in the process becoming the first truly global providers of voice telephony service.

While major alliances such as Concert or World Partners offer switched voice service to customers in only 25-30 countries, alternative service providers are already offering comprehensive geographic origination, genuine cost savings, a range of enhanced services and single-source billing to switched voice customers in more than 200 nations and territories worldwide. Fundamentally, this has occurred because alternative service providers do not accept the traditional monopoly paradigm that has governed relations between correspondent carriers for the past 120 years. Instead, they represent a new and revolutionary *market-driven* paradigm, which—by virtue of its ability to reduce costs to end users, as well as to expand the nature and quality of services offered—will dominate the telecommunications industry of the twenty-first century.

Callback, international simple resale (ISR), refiling, voice over frame relay, and voice over the Internet all represent market-driven forms of telecom arbitrage or technology. In contrast to these alternative calling procedures, monopoly telecoms represents a form of central planning, in which a handful of individuals decide the telephony fate of a nation. In a free market, on the other hand, economic decisions are made by millions of individual consumers, each pursuing his or her perceived best interest in light of the best available knowledge.

An Irresistible Tide of Change

In March 1996, several Japanese carriers presented a series of white papers to the ITU-T, arguing that callback, refiling and other alternative calling procedures distort international traffic patterns, making it impossible for international carriers to conduct rational long-term network planning.

The U.S. delegation to this ITU conference acknowledged that alternative calling procedures may render long-term network planning difficult for international carriers whose collection and accounting rates are set far above cost. However, the U.S. delegation also emphasized that alternative calling procedures actually make rational economic decision-making possible for the first time by telecom customers in many countries, as end users decide how to route their international traffic through a variety of carriers that are competing for their business on the basis of cost, quality and service.

Despite the fervent desire of some PTTs and PTOs to cling to the comfortable ways of the past, global market liberalization cannot and will not be stopped. This is because liberalization is a product of three irresistible forces, all converging simultaneously:

1) technology, in the form of low-cost digital fiber optics and cheap, readily available switching capacity, which enables new market entrants to process millions of calls at an extremely low per port, per minute cost;

2) competition in North America, Europe, Australia, etc., which forces carriers in these markets to offer wholesale domestic and international transport services at a price close to actual cost—stimulating, in turn, the export of relatively inexpensive dial tone to less competitive markets; and

3) the economic necessity for every nation to secure low-cost telecom service, in order to become or remain competitive in today's global economy.

Widespread industry recognition that these converging forces cannot be reversed has led to a fundamental sea change in the global telecom industry over the past two years: viz., the intellectual triumph of the market paradigm.

The Regulator's Response

During the early years of callback, monopoly regimes had hoped that the U.S. Federal Communications Commission would act decisively to stop call reorigination in its tracks. Simultaneously, conservative PTTs and PTOs sought to enlist the aid of the International Telecommunication Union in their holy war against call reorigination.

Neither the FCC nor the ITU has proven cooperative in the suppression of alternative calling procedures, however. The FCC—intellectually committed to market liberalization and with an eye to reducing the U.S. trade deficit (which was augmented by $5.5 billion in net settlement outpayments in 1995)—twice ruled in favor of callback, declaring it to "serve the public convenience and necessity."

In 1994, the Kyoto Plenipotentiary directed the ITU-T to study the impact of callback and other alternative calling procedures upon the international network and the ITU's member states. Two years of deliberation failed to produce any consensus for suppression of the most common forms of alternative calling procedures. Instead, the ITU-T, at its triennial World Telecommunication Standardization Conference in October 1996, resolved that "...in order to minimize the effect of alternative calling procedures a) ROAs should, within their national law, make their best efforts to establish the level of collection charges on a cost orientated basis taking into account Article 6.1.1 of the International Telecommunication Regulations and ITU-T Recommendation D.5; b) Administrations and ROAs should vigorously pursue the implementation of Recommendation D.140 and the principle of cost orientated accounting rates and accounting rate shares" (ITU-T Resolution 29).

The pain that many PTTs and PTOs currently experience—which they often attribute to "unauthorized competition" from companies using alternative calling procedures—actually results from the coexistence of monopoly and market-driven paradigms in the world today.

The competition that now exists in liberalized markets is not going to disappear in the months and years ahead. On the contrary, it will increase substantially, and continue to be exported in the form of call reorigination, refiling and private line resale to every market in the world whose incumbent operator seeks to maintain the high profit margins historically associated with monopoly telecoms.

Operators in nations that liberalize early will enjoy a decisive advantage in the years ahead, having secured more time than their competitors in non-liberal markets to engage in an "exercise routine" that is guaranteed to produce relative leanness and efficiency in those operators that survive. As a logical corollary, incumbents whose markets liberalize late in the game are likely to be at a significant disadvantage, for they will have to engage in a crash program to trim fat while lean competitors are already pouring across the border into their traditional market.

The crisis faced by legacy carriers is their need to quickly rebalance tariffs and achieve economic efficiency amidst an assault by new technologies and competitors. Thus, the single most important thing an incumbent operator can do to ensure its future competitiveness is to lower its existing cost structure, without delay.

A Compelling Rationale for Market Liberalization

In a world of global competition, it is no longer possible to cross-subsidize domestic service or institutional inefficiency by maintaining high international collection rates. Similarly, the proliferation of knowledge and competition virtually ensures that artificially high accounting rates will be circumvented, either by refile or other forms of creative by-pass.

Determined to reduce the charges that U.S. carriers pay foreign monopolies to complete overseas calls that are made from the United States, the FCC is assuming an ever more active role in driving accounting rates down towards actual cost. In the U.S./UK market, the FCC and Oftel have agreed to waive proportionate return altogether, signaling the demise of the accounting rate system on this key North Atlantic route. The recent issuance of 46 new international facilities licenses by British regulatory authorities signals that, within months, spot prices for international telecom services will become roughly equal in New York and London, as the wholesale commoditization of international long distance service replaces the old duopoly of Mercury and BT.

With the advent of January 1, 1998, most member states of the European Union, North America and Australia/New Zealand will constitute a telecom free trade zone, in which private line voice traffic that enters any of these three regional markets can automatically flow to the others—outside the accounting rate system.

We are now witnessing not only the rapid disintegration of the old monopoly paradigm of telecoms, with its emphasis on bilateral correspondent relations, but also the simultaneous convergence of voice and data services. In this context, the greatest significance of voice telephony over the Internet is not likely to be its role as a protocol for actually transmitting the world's telephone conversations over a public data network. Rather, voice over the Internet highlights the artificiality, and extreme vulnerability, of the traditional accounting rates system.

In many parts of the industrialized world, Internet access is priced artificially low, while long distance collection rates for PSTN service are set artificially high. As soon as Internet telephony reaches an acceptable level of quality and convenience for a mass market of end users, operators will be forced to adopt cost-based pricing of PSTN voice telephony service—acknowledging, in economic practice, what telecom engineers have stated for years: that voice traffic itself is no longer anything but a series of digital bit-streams (i.e., data), circling the globe at the speed of light.

Given these economic and technological developments, the placement of artificial regulatory restraints on the provision of telecom service no longer appears to be either desirable or viable for governmental authorities. While this may create short-term pain for incumbent operators, the mid- to long-term societal benefits of market liberalization are potentially enormous. Low-cost telecom service is a critical success factor for businesses competing in the information age, amid the wide-ranging opportunities and pressures of a truly global economy. High-quality, low-cost telecom service is no panacea, but it does provide one of the fundamental preconditions for rapid economic growth—lacking which no modern nation can realize its full economic potential. The deregulation of telecom markets is, in addition, a harbinger of more widespread economic liberalization, with all the material and moral benefits to society which this entails.

The Moral Imperative

In 1993, when USA Global Link began to conduct business in East Africa, a telephone call from Nairobi to London cost approximately US$6.00 per minute, with a three-minute minimum call length. In effect, the Kenya Posts & Telecommunications Corporation charged customers $18.00 to send a one-page fax from Kenya to the UK. With the cost of international communication prohibitively high, it was no wonder that most of USA Global Link's East African customers were international aid agencies such as the Rockefeller Foundation, CARE International or Medecins sans Frontieres, rather than the dynamic small- to medium-sized business clients which represent the company's core constituency in the Asia-Pacific region.

In many nations, the effects of this monopolist mentality are far-reaching and profound. To cite just one example: several years ago, USA Global Link established a relationship with a family-owned African firm to sell discount telecom service. In the course of routine business discussions, one of the firm's associates mentioned that his family imported trucks to a particular East African nation, enjoying a 300% profit as soon as their trucks rolled off a ship and onto the dock.

When asked how he could sustain so large a profit margin without attracting competition, the gentleman laughed and replied that his family had a monopoly on the importation of trucks to this particular country. If anyone else was caught smuggling trucks into the country, they would be arrested, and the contraband vehicles turned over to his family.

Further questions revealed an interesting pattern: as the newly imported trucks drove inland, they were required to purchase fuel from a company that enjoyed a monopoly on diesel and gasoline; the trucks were then loaded with raw materials extracted from the earth by a handful of politically well-connected families, which had exclusive government licenses issued for this purpose; and finally, these same trucks drove back to the coast and loaded their cargo on ships bound for the industrial centers of North America, the Pacific Rim, and Europe.

In this particular country, the privileged few who possess a monopoly license live in comfortable, air-conditioned homes amid the sweltering African heat. They drive Mercedes-Benz automobiles, have Swiss bank accounts, and generally send their children to the best schools in England or the United States. Yet for decades, the vast majority of this nation's population has remained mired in poverty, ignorance and disease—trapped by a political system that virtually precludes the development of small businesses and an economically vibrant middle class.

Alternative calling procedures shatter the hegemonistic monopoly paradigm described above, adding technological inevitability to the moral and intellectual arguments for widespread market liberalization. Earlier this decade in Argentina, president Carlos Menem placed telecoms "at the heart" of his government's efforts to solve endemic problems of hunger, disease, and subpar economic performance. Privatization of Argentina's telecom network in 1989 has led to rapid growth in fixed lines, and a marked improvement in the quality of network performance.

Of course, such changes require the acceptance of a new paradigm for financing network expansion and provision of universal service. Yet the path of market liberalization suggested by these developments has time and again proven itself more effective at expanding teledensity and stimulating economic activity than decades of cross-subsidization.

Venezuela, which privatized its telecom sector in 1991, can be viewed as a prime example. The resulting $1.1 billion upgrade in the nation's telecommunications infrastructure was more than had been spent during the previous 20 years. Hundreds of thousands of new customers were added as the speed of provisioning new lines increased dramatically.

A New Era

The inevitable logic of reducing accounting rates to a cost-oriented basis—or abandoning the system altogether as more and more countries adopt a competitive telecom paradigm—will soon replace the artificiality of an outmoded regime with the authenticity and purity of a virtual commodity exchange, in which digital bit-streams seek and find the most economically efficient route to their global destination.

Whatever replaces the current accounting rate system—whether cost-oriented settlement rates, termination charges, interconnect fees, or simple break-out through the PSTN—competition will demand that the resulting reduction in underlying operator costs be passed along to end users. This inevitable development, once embraced by members of the Asia-Pacific community, will usher in a new era of cost-based telephony service, which will boost the economies of the Pacific Rim, and thrust the region's telecom industry to the forefront of global competitiveness.

Foreign banks and electronic banking services in Shanghai (1)

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Abstract

More times than not the banking and financial services sector is a leading, if not *the* leading, user of telecommunications services, but despite projects like the Golden Card China's very cautious approach to banking reform, and restrictions upon foreign banks may be hindering the potential for technology transfer and market growth. This may mean the banking sector in China does not become the leading edge of telecommunications as elsewhere in the world. In light of this, the following paper reports some research results by the Telecommunications Research Project looking at the use of electronic banking services by foreign banks in Shanghai.

Introductory Overview

More times than not the banking and financial services sector is a leading, if not *the* leading, user of telecommunications services. This is especially true of data communications and long-distance and international telecommunications. In China the sector is tightly controlled for reasons of national security and economic sensitivity. The Chinese government quite understandably places a priority on monetary stability to avoid fueling inflation; on interest rates and credit control to balance the need for state enterprise reform with the need to provide lines of credit to state enterprises in trouble; on the target of currency convertibility to encourage long-term foreign investment in China; and on banking reform.

The last is part of the general reforms of state enterprises and of the shift to a market economy, providing China's major banks with greater business and financial autonomy. China banks cannot hope to compete against foreign banks in terms of productivity, profitability or service standards in the short-term, but they need to begin the transition. Two elements are vital in this. One is the adoption of modern information technologies for internal management efficiency and external networking efficiency. The other, and the more difficult to achieve, is the acquisition of modern management approaches, skills and techniques and ways of working. These are qualitative issues as much as quantitative issues.

An irony arises at this point. The priorities assigned to the banking sector are reflected in the importance and high-profile attached to the Golden Card (debit and later credit card networks) and the Golden Finance (bank clearing networks) projects. However, this seems to be creating problems of CO-ordination and CO-operation between Beijing and provincial-level authorities. While the Beijing authorities exercise central bureaucratic control the provincial-level authorities want to build-out their own systems according to local priorities. This creates something of a pressure-cooker effect within the banking sector, which in turn creates a contradictory situation whereby some banking managers want to open dialogue as far as possible with foreign banks to exchange ideas about technologies and possible a CO-operation leading to the transfer of management knowledge and skills, while other authorities close down meaningful contacts and impose a veil of exclusion over the sector. What this may mean in practice is that the banking sector in China does not become the leading edge of telecommunications as elsewhere in the world.

The experience foreign banks have in the use of telecommunications and IT in the promotion of electronic banking services can and should be a valuable import into China's financial sector. The Telecommunications Research Project (TRP) therefore undertook a study of the foreign banks in Shanghai to see just what services they were offering or intending to offer by electronic means. The survey was based upon a questionnaire to all branches of foreign banks in Shanghai - 31 at the time of the research July/September 1996 - with follow-up interviews of one-third. In total 27 questionnaires were returned, but one of these was nearly blank so 26 were usable.

Foreign banks are restricted in what they can do in China, the major restriction being a prohibition upon

RMB retail banking. However, there is a grey zone of uncertainty as to what the banks can and cannot do, especially in the means of service delivery by telecommunications and the nature of the services they can provide over their own networks. The following paper summarizes some of the evidence from the Shanghai .

Research findings

1. Banks ownership and services

As table 1 details, of the twenty-six banks in the sample eleven were Asian-owned, twelve European-owned, and three North American-owned. Of the Asian-owned banks, six are Japanese, three Hong Kong, and two from Thailand. This contrast may simply reflect the fact that Japan and Hong Kong are the two major financial centers in Asia. Another possible reason is the proximity of Japan and Hong Kong to Shanghai.

See Table 1

Table 1 also shows that eight banks offered retail services, five of which were exclusively retail banks. Of the eighteen banks offering wholesale banking services, fourteen were exclusively wholesale. Only three banks offered both range of services. Four banks offered 'other' services named as investment and trade finance, and again the majority, three of them, only offered 'other' services. From Table 1 it is immediately obvious that all five retail-only banks are Asian-owned. Asian banks are equally engaged in wholesale banking, whereas European and North American banks are more heavily engaged in wholesale and merchant banking. It appears that foreign banks in Shanghai tend to specialize in the markets they serve. Not surprisingly, wholesale/merchant banking dominates foreign bank activity, with 69 per cent of banks offering these services. Banks interviews reveal that their main lines of business are trade finance, settlements and foreign currency remittances, and the main activity is the issue of letters of credit. Until renminbi deposit taking is permitted for foreign banks in China it is natural that these will be the primary activities of foreign banks as they seek to service companies from their home countries.

2. The grey zones and services:

2.1 Saving, deposits and loans services

Due to the fact that foreign banks are not permitted to undertake RMB retail banking business, most of banks focus upon wholesale and merchant banking. There was one exception to the rule, which was a 'foreign' bank which historically was founded and registered in China, and is treated today as a Chinese bank for purposes of RMB deposit-taking. Otherwise, until RMB deposit-taking is opened up to foreign banks - the first experiment in China is due to take place in Shanghai's Pudong district (3) - the main deposit-taking activities of foreign banks consist of time deposits, foreign currency savings accounts and current accounts. Foreign banks differed in their perceptions of who and when they would be permitted to provide RMB banking . As table 2a shows, three banks believed they would provide RMB banking within either 12 months or 3 years, while another twelve banks reported that they would do so if permitted. For banks who know they qualify according to the regulations announced - see footnote 3 - there is a high degree of certainty, although the timing of the decision remains unclear. For the other banks, they do not know for sure whether the will automatically receive permission when they qualify or whether the rules will be changed before they qualify. Only four banks were unlikely to provide renminbi savings accounts even if permitted

See Table 2a

2.2 Debit cards and Automatic Teller Machines

Another uncertainty for banks is whether they are permitted or not to offer debit cards and build and operate ATM networks. In Shanghai only one foreign bank has obtained a special license from the People's Bank of China to operate an ATM in Shanghai. This is done in CO-operation with the Industrial and Commercial Bank of China. The service is provided from two ATMs in the Bound area in Pixie. ATM services are offered to the holders of credit and debit cards issued by banks in Hong Kong. Payments systems offered include Cirrus, Mastercard, Visa and Citibank debit card. The service offered includes cash withdraw from multiple accounts, cash withdraw from credit cards, cheque deposit, fund transfer and account inquires.

See Table 2b

The responses indicate that within three years seven banks (27 per cent) would like to provide debit card

Ownership of banks by country of origin and service type

Table 1

	Asian	European	North American	Total
Retail	5(19.2%)			5 (19.2%)
Wholesale/Merchant	4(15.3%)	8 (30.8%)	2 (7.7%)	14 (53.8%)
Others	1(3.8%)	1 (3.8%)	1 (3.8%)	3 (11.5%)
Retail/Wholesale/Merchant	1(3.8%)	2 (7.7%)		3 (11.5%)
Retail/Wholesale/Merchant./ Others		1 (3.8%)		1 (3.8%)
Total	11 (42.3%)	11 (42.3%)	3 (11.5%)	26 (100%)

Savings, deposits and loans services

Table 2a

	RMB Saving Accounts	Foreign Currency Savings Accounts	Current Accounts	Time Deposits
Currently provided	1 (3.8%)	19 (73.1%)	18 (69.2%)	20 (76.9%)
Currently not, but within 12 months	2 (7.7%)		1 (3.8%)	
Currently not, but within 3 years	1 (3.8%)	1 (3.8%)	1 (3.8%)	1 (3.8%)
Provide within 12 months if permitted	8 (30.8%)			
Provide within 3 years if permitted	5 (19.2%)			
Not likely to provide	4 (15.4%)	3 (11.5%)	3 (11.5%)	2 (7.7%)
Missing	5 (19.2%)	3 (11.5%)	3 (11.5%)	3 (11.5%)
Total	26 (100%)	26 (100%)	26 (100%)	26 (100%)

Debit cards and ATMs

Table 2b

Debit Cards	ATM	EPOS/EFT
Currently provide	1 (3.8%)	
Currently not, but within 12 months	1 (3.8%)	
Currently not, but within 3 years.	3 (11.5%)	2 (7.7%)
Provide within 12 months if permitted	1 (3.8%)	
Provide within 3 years. if permitted	2 (7.7%)	2 (7.7%)
Not likely to provide	12 (46.2%)	13 (50%)
Missing	6 (23.1%)	9 (34.6%)
Total	26 (100%)	26 (100%)

Automatic teller machines

Table 2c

ATM network	Self-operated	Jointly with foreign banks	Jointly with China banks
Currently provide	1 (3.8%)		1 (3.8%)
would provide within 3 years	4 (15.4%)	5 (19.2%)	5 (19.2%)
Would provide within 3 years if permitted	4 (15.4%)	4 (15.4%)	3 (11.5%)
Would not provide	11 (42.3%)	11 (42.3%)	11 (42.3%)
Missing	6 (23.1%)	6 (23.1%)	6 (23.1%)
Total	26 (100%)	26 (100%)	26 (100%)

ATM services. Two of the responses assume that it is not currently permitted, while four assume that it is possible. These responses also illustrate the same problem, along with other foreign commercial ventures, frequently face in China, an absence of clearly formulated commercial law and policy by the authorities. Often, what can and cannot be done is determined during the event rather than before it. (4)

Perhaps more surprising almost half of the banks are not likely to provide debit card ATM (46.2%) and EPOS/EFT (50%) services. In competitive retail banking markets ATM and EPOS/EFT systems provide banks with a strategic advantage, but in Shanghai the conditions of competition do not yet exist, and will not until renminbi deposit-taking is permitted on a wide scale. Merchant banking (see above) remains the primary activity of foreign banks. The other advantage ATM networks offer banks in competitive markets are cost savings. Estimates of the relative transactions costs of postal check clearing, branch teller service and ATM cash deposits and withdrawals in Britain suggest ratios of 60:20:10 (5) but these savings assume bank labour costs vastly higher than those in China. To make such networks cost-effective there needs also to be an economy of scale in usage, but in China still only a minority of employees have bank accounts, let along auto-pay, and those that do may be reluctant to trust cash to machines or take cash from machines. However, against this the build-out of the Golden Card and Green Card (a Post Office Giro card very successfully promoted by the MPT) projects and the promotion of China bank debit cards, and some credit cards, along with shop loyalty cards, will influence a change in consumer tastes and habits. (6)

A maximum of eight banks (30.7 per cent) would offer electronic banking services of some kind through the operation of an ATM network. These include only three of the eight retail banks. Table 2c suggests no significant preference for self-operated, or joint operations with other foreign banks or China banks.

Table 2c

2.3 Credit Card

The response is comparable to the debit card question. Almost half of the banks are not interested in providing a credit card service in China. The clearing and payback system in China is still not well-developed, it is not easy for banks to chase customers in China, and local income and therefore credit risk remains high. Also, the use of credit cards is not well established among either merchants or customers, and the issue of credit cards for non-specialist banks would entail high transaction costs but low or uncertain profit margins.

Table 2d

2.4 Electronic Banking services

In the case of electronic banking services, again the answers range between banks who appear to assume that these services can be introduced and those that assume they require prior permission. A substantial proportion of banks intend to offer electronic banking services within the next three years. Ten banks intend to use Financial EDI which would bring the total number to twelve (46 per cent) and seven banks in addition to the existing three would introduce PC banking. Eight banks would introduce Internet banking and eight banks in addition to one existing bank would introduce phone banking. Smartcards are being considered by nine banks and smartphones by seven banks. Pager and fax (four existing) banking services are being considered by seven and six banks respectively, and five are considering mobile telephone banking. The virtual kiosk is being considered by six banks (23 per cent) - three points less than the proportion of banks considering ATM networks.

Table 2e

Constraints

These grey zones arise because China has not yet developed a defined policy, still less a timetable, governing the range of services and service delivery mechanisms which the foreign banks can provide. It is not even clear, for example, whether permission to operate an ATM network is required, and if so whether it comes from the PBOC, the MPT or the local PTA. At this stage China itself does not know because the issue has hardly been tested, and where it has there seems little consistency of view.

One of the main causes of uncertainty arises from problems of co-ordination and co-operation between Beijing and provincial-level authorities. While the Beijing authorities exercise central bureaucratic control the provincial-level authorities want to build-

Credit cards

Table 2d

	China Credit cards	Foreign Credit cards	Loyalty Cards
Currently provide		6 (23.1%)	1 (3.8%)
Currently not, but within 12 months	1 (3.8%)	1 (3.8%)	
Currently not, but within 3 years	2 (7.7%)	2 (7.7%)	1 (3.8%)
Provide within 12 months if permitted	2 (7.7%)		2 (7.7%)
Provide within 3 years if permitted	2 (7.7%)	1 (3.8%)	2 (7.7%)
Not likely to provide	13 (50%)	12 (46.2%)	13 (50%)
Missing	6 (23.1%)	4 (15.3%)	7 (26.9%)
Total	26 (100%)	26 (100%)	26 (100%)

Electronic banking services

Table 2e

	Currently provided	Provide within 3 years	Would provide within 3 years if permitted	Not likely to provide	did not answer	Total
Financial Electronic Data Interchange	2	7	3	7	7	26
Virtual Kiosk		4	2	13	7	26
Smartcards		5	4	11	6	26
Smartphone		3	4	12	7	26
Fixed Wireline Phonebanking	1	6	2	10	7	26
Mobile Phone Banking		5	1	13	8	26
Fax Banking	5	5	1	8	7	26
Pager Banking		4	3	13	6	26
PC Dial-up Banking	3	6	1	8	8	26
Internet Banking		8		11	7	26

out their own systems according to local priorities. This creates something of a pressure-cooker effect within the banking sector, creating in turn a contradictory situation whereby some bank managers want to open dialogue as far as possible with foreign banks to exchange ideas about technologies and possible a co-operation leading to the transfer of management knowledge and skills, while other authorities close down meaningful contacts and impose a veil of exclusion over the sector.

From the foreign banks' perspective, they are unlikely and unwilling to commit large investments when there areas of operation remain very much in the grey zone. Instead, they concentrate most of their business activities on serving international companies with letters of credit, loans and other trade-related business. *What this may mean in practice is that the banking sector in China does not become the leading edge of telecommunications as elsewhere in the world.*

The research identifies the danger that, ironically, China's banking sector will be held back by an excessive degree of bureaucratic effort to oversee its reform, while other sectors, such as China's stock markets and futures exchange which are far more lightly regulated - and which are negotiating with foreign companies and JiTong Corporation - will race ahead in the implementation of information technologies. This emphasis on control is consistent with China's history since the 1978 'Open Door' policy. A very cautious Chinese leadership, divided within itself as to direction, implementation and speed of reforms, has experimented with special zones, isolating them from the rest of the economy, and society, until their effects can be observed. This is exactly the approach being adopted towards the participation of foreign banks within China. Since the rise of the 'Shanghai faction' to China's top leadership the Pudong area of Shanghai has been selected as the first locality in which foreign banks may be permitted to experiment with renminbi deposit-taking. The selected banks will be limited to those who have maintained branches in China for at least three years, who have made profits for at least two years, and who have monthly outstanding loans of at least US$100 million. They must be prepared to maintain at least a sub-branch in Pudong.

One effect of this situation is that the services currently offered by foreign banks in China, including in Shanghai, and their plans to introduce new services in the foreseeable future, are likely to be more limited than might normally be the case even in a less developed country such as China. Against this, the potential size of China's domestic markets is attracting international companies from the world over, and foreign banks are there to serve them. China's telecommunications networks, while still very much underdeveloped by developed country standards, are nevertheless being rapidly built out, especially in cities like Shanghai, offering opportunities for the future which many other developing countries cannot match. The monopoly exercised by the MPT - the DGT or China Telecom - over international gateways and the closed local market remain as major obstacles to foreign carriers wanting to serve directly international companies in China, and the banks that serve them. These restrictions are unlikely to be lifted soon, but one of the pressures that could influence decisions in this area will be the efficiency with which banks in China can serve the market, not least China banks as and when they develop international transactions and correspondent banking relationships on a larger scale.

For those foreign banks they are running their business by cooperated with Chinese banks. It is sure one of the solution to escape from being blocked by the obscure policy and regulation but also leave them more flexibility in the type of services and the cost of investment. One of the example we illustrated above is the bank run ATM network with ICBC. Though it seems a solution right now, it is also have the limitation by the construction of China Golden Card network and Golden Finance Project. Without an efficient clearing and transaction network, it is very difficult for foreign banks have interest in running those kind of banking service.

The Future: Convertibility

A decisive step towards liberalization will be the declaration of *current account* renminbi convertibility - *capital account* convertibility would signal the transformation of the sector. China announced that in June 1996 free forex trading for foreign firms will be extended from the four experimental areas - Shanghai, Shenzhen, Dailian and Jiangsu - to the rest of the country. However the date for renminbi current account convertibility keeps shifting, and it remains unclear whether it can be achieved by early 1997 or not. The loss of control of domestic interest rate policy is a primary concern, especially at a time when state enterprise reform is severely testing lines-of-credit from China banks to keep some many of these enterprises afloat.

However, the first signs of a market opening in China for foreign banks will see an enormous surge of banking interest. As in other areas of telecommunications, the use of modern electronic service in China, albeit on a selective basis, can start from the point where the banks have no overhang of antiquated branch networks and working practices. The use of IT and telecommunications for the provision of Internet and PC banking, ATMs and EPOS, virtual kiosks and smartcards, will accelerate, as will domestic and international data and transactions traffic. Banks will require China satellite and digital data network hubs, ISDN and ATM switched PSTN and PSDN networks to rely upon, as well as databank hardware and software to manage their business. This is the scenario which the OECD countries are use to. The PTAs in cities like Shanghai are equally looking towards such developments. These technologies and the skills in managing them can be transferred from the foreign banks, and this in turn opens opportunities for strategic alliances and joint ventures with China banks.

As in so many other areas of IT, the major constraints lie not in technological difficulties nor in demand deficiencies, but in policy and regulatory hurdles. China has many sensitive areas in which policy and regulations are striving to find a way through, such as Internet, media and information issues, and it is made doubly complicated by the many different ministries and other parties at China's bargaining table. From an economic viewpoint, monetary and banking issues are perhaps the most sensitive of all, but currently China risks losing the opportunity these sectors can offer in their role as drivers of IT.

Endnotes

1. The project was a partnership between the TRP, the Shanghai PTA, the Shanghai Institute of Economic Development (SIED) and AT&T who funded the research. This paper draws upon some of the research findings.

2. Dr John Ure is the director of the Telecommunications Research Project. Ms Chan So Kuen is Research Officer and research manager of the TRP.

3. The conditions the RMB banking services provider needs to fulfill are:

a. the bank has a branch in Pudong,

b. the bank has had a branch in China for at least three years,

c. the bank has been in profit in China for at least two years,

d. the bank has outstanding loans in China of at least US$100 million

4. Other research by the TRP in Shanghai and other cities supports this view. PTAs in different cities give different responses to whether foreign banks can be allowed to lease circuits to run their own ATM networks, but the bottom line is that the issue has rarely been tested. In Beijing and Guangzhou cases of foreign banks operating or sharing ATMs exist.

5. An estimate by Deloitte Touche Tohmatsu *The Future of Retail Banking* (1995) estimates phonebanking compared with branch banking cuts transactions costs by as much as 40%. McKinsey and Co. take an alternative view of technology, seeing its importance more in the direction of creating 'new business than closing retail branches.

6. For details of China's debit and credit cards see the seminar papers from the TRP's *Banking, Financial Transaction Services in China* 18th March 1996, Shanghai Hilton Hotel. (Visit http/www.lawhk.hku.hk/trp/homepage)

7. See Chi Lo, 'The Renminbi and China's Reluctance to Let Go", The Asian Wall Street Journal, November 21, 1996 for a useful review of the issues.

The impact of wireless telecommunications on universal access in emerging countries

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Abstract

This paper provides a perspective on the potential of wireless technologies in providing universal access to telecommunications services in emerging countries. Digital cellular, PCS/PCN and wireless local loop technologies are often positioned as the solution to improve a low teledensity and introduce competition in stagnant telecommunications markets. Many developing countries are awarding licenses to new operators for wireless local loop networks to increase penetration of fixed telecommunications in areas which have been traditionally underserved.

This paper focuses on identifying the conditions necessary to successfully sustain the development of markets for mobile and fixed wireless telecommunications services. Firstly, industry structure, policy and regulatory environment as well as level of competitive rivalry are discussed as setting the stage for the rapid and successful development of new telecommunications services.

Secondly, a methodology developed by LEMAY-YATES ASSOCIATES to assess the attractiveness of particular markers is discussed. This methodology aims to assess the conditions necessary to develop both the residential or consumer markets and to business applications for wireless communications. The paper concludes with a discussion of the potential of wireless telecommunications to provide universal access.

1. Introduction

The objective of this paper is to provide a perspective on the potential of wireless technologies in providing universal access to telecommunications services in emerging countries. Mass market applications of digital cellular and PCS/PCN technologies, for mobile and fixed applications, are often positioned as the solution to improve a low teledensity and to introduce competition and dynamism in stagnant telecommunications markets.

Some developing countries such as India are awarding licenses to new operators for fixed wireless local loop networks, in addition to mobile telephony licenses, to increase penetration of telecommunications.

Other countries, as in the case of Romania, prefer the approach of providing incentives to new mobile operators to increase the usage on their networks by offering a range of fixed or limited mobility wireless services. These services enable the new operators to address broader segments of the market in a speedy manner as well as territories which have been underserved by the Public Switched Telephone Network.

As a point of comparison, in Canada, fixed wireless technologies such as Low Power Multipoint Communications Systems (LMCS) are perceived as key enablers to foster competition in local telecommunications services and in cable TV applications. In the United Kingdom, spectrum in the 3.5 to 4.2 Ghz range was allocated to two new operators, Ionica and Liberty Communications, with the objective of creating a competitive local loop environment as quickly as possible

This paper focuses on identifying the conditions necessary to successfully sustain the development of markets for mobile and fixed wireless telecommunications services. The discussion focuses on:

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- issues dealing with government policy, industry structure and regulatory environment; and
- socio-economic and demographic characteristics impacting the development of wireless telecommunications.

Conclusions are drawn on the potential contribution of wireless telecommunications to increase teledensity in emerging countries. Key elements of this paper have been developed based on an assessment conducted by LEMAY-YATES ASSOCIATES of the development of telecommunications markets in emerging countries in Eastern Europe, such as Poland and Romania , and Asia-Pacific.

2. Government policy, industry structure and regulatory issues

The combination of government policy, industry structure and regulatory environment in a particular country are critical elements that set the stage for the speed of deployment and eventual success of new wireless telecommunications operators. Each of these elements is briefly discussed herein.

Government policy has a significant impact on the potential increasing use of wireless telecommunications. We identify six key elements forming the cornerstone of government policy.

1. The first element relates to the level of competition to be introduced. There is now substantial corroboration that stronger competition significantly increases the growth rate and penetration of mobile telecommunications services. This conclusion appears to be valid in emerging countries as well as in more developed countries.
   For example, Canada and Australia are countries with similar geographic and socio-economic characteristics. At the end of March 96, the penetration rate of cellular telecommunications was 20% in Australia versus only 10% in Canada. There have been three operators of wireless communications in Australia since 1993 while Canada has had a duopoly since 1985[1]. The level of competitive rivalry in the market appears to be a major element explaining this very substantial difference in penetration.
   Similar conclusions can be drawn when comparing the cellular penetration rates between Hungary, Poland and Romania. Hungary leads the pack with a total penetration of 2.8% (and 2 operators) while Poland lingers at 0.26% awaiting the initiation of service by two newly licensed GSM operators and Romania closes the march at 0.05% penetration (with 1 NMT-450 operator and 2 GSM licenses recently awarded in November 1996).
   The evidence also strongly suggests that a duopoly is often not sufficient to provide the incentive necessary to maximize the development of wireless telecommunications in a given country.

2. The second element is the bandwidth of spectrum allocated to wireless operators. Spectrum in the various bands often has to be re-assigned to provide frequencies for wireless operators. The amount of bandwidth provided to the wireless operators (for example, 4.5 MHz versus 15 MHz) can have a significant impact on how mass market applications can be addressed. This is especially significant when one considers that fixed wireless applications exhibit higher traffic characteristics than mobile applications thereby contributing to increasing congestion on wireless networks.

3. The third element is the treatment of interconnect fees. Interconnect fees, usually expressed in cents per minute, are the amounts exchanged between the PSTN and the wireless operators for termination or origination of calls. Owing to the imbalance between originating and terminating traffic on wireless networks, interconnect fees have a substantial impact on the minimum call minute charge which can be offered by wireless operators, at least in the initial years. There is currently a wide range of interconnect fees from as

low as less than $0.03 per minute to $0.12 or higher in certain cases. Payment of interconnect fees based on the "bill and keep" approach or at least using a cost based approach are important to promote low tariffs and stimulate the growth of both mobile and fixed wireless communications services.

4. The fourth element is the participation of foreign firms. Foreign wireless operators bring know-how, expertise and capital to launch mobile operators. This is a model now widely used across the world. What varies is the level of participation allowed to foreign operators. Typically, foreign operators will want to maximize their share while governments will look to maximize the participation of domestic firms. The positioning of either group vis-à-vis the 50% equity level is usually dependent on the attractiveness of the market for foreign investors and on the quality of foreign operators a particular country wants to attract.
   It should be noted that foreign participation in a wireless operator is no guarantee of success. Centertel in Poland and Telefonica Romania both benefited from the expertise of foreign operators from their inception. However, since no competitors were simultaneously introduced in the market, these operators lacked the necessary incentives to rapidly deploy their networks and lower tariffs to increase penetration.

5. The participation of state owned operators in wireless communications consortia can also have a significant impact. Many governments had adopted the approach of strong participation by the state owned PTT for the launch of analog cellular operators in the early 1990's. Subsequently, in some cases, in light of the disappointing results, a completely different approach was used to award GSM licenses. A case in point is Poland where the local telephone company TPSA was clearly discriminated against when the conditions for the GSM license application were issued.

6. The expected introduction of future wireless operators such as PCS or DCS-1800 also significantly impacts the perspective of newly licensed operators. Especially in less attractive markets, if the award of new licenses is considered before existing operators can become successfully established, a negative impact on network deployment and tariff reductions may ensue as operators are faced with very short timeframes to recover their investments. At the very least, a clear plan as to when future licenses will be awarded and clear eligibility criteria enables would be operators to develop their business plans accordingly .

Many emerging countries are characterized by uncertainty regarding the regulatory function. More often than not, this function is accomplished within the Ministry of Communications. Rules and procedures for approval of tariffs are unclear. Some governments also put forward the concept of maximum tariffs to ensure widespread accessibility to wireless communications. From the perspective of stimulating the growth of wireless communications and considering that wireless markets usually exhibit a significant level of competitive rivalry, no or little regulatory oversight with respect to tariffs can be justified to provide maximum flexibility to operators and foster a dynamic market driven environment.

3. Market attractiveness and impact of socio-economic and demographic environment

LEMAY-YATES ASSOCIATES INC. has developed a methodology to estimate and project demand for wireless telecommunications services in various countries. This methodology takes into account specific inputs which are :

1) the anticipated network coverage and deployment plan,
2) the framework put forward in the license conditions and

Table 1

Countries	Year of introduction of wireless services	GDP per capita in 1994	Cellular penetration as of IQ 1996	Expected cellular penetration in year 2000
India	1995	300	0.01%	0.21%
Taiwan	1990	12,573	4.69%	10.65%
Poland	1992	5,768	0.26%	2.92%

3) an exhaustive assessment of the socio-economic characteristics of a country as well as expected evolution.

The analysis of the socio-economic environment is based on extensive secondary and primary research and focuses on the anticipated evolution of employment as well as on the ability of consumers to afford the said wireless services.

The first step consists in the analysis of macroeconomics indicators in the country under study and comparison with countries exhibiting macroeconomic similarities. A macroeconomic variable of first importance is the gross domestic product (GDP) per capita of the country. As this variable shows the level of wealth of the country, it provides a direct link with the population who can afford a wireless phone. As indicated in Table 1, countries with higher GDPs per capita also generally exhibit higher current and anticipated cellular penetration rate (year 2000 estimates were developed by LEMAY-YATES ASSOCIATES).

As shown in Table 1, even if one takes into account the year when wireless services were introduced in each country, Taiwan is the leader in terms of penetration rate. Thus, when analyzing the demand for new wireless services in a country, evolution of wireless penetration rates in countries having similar GDP per capita and economic context can be used as bench-marks.

However, GDP per capita is not the only important factor. Others include the evolution of the exchange rate, inflation, the composition of employment and the proportion of workers employed in the private sector. The latter is particularly important when assessing the market attractiveness of ex-communists countries where mass privatization programs are under way as part of a the re-structuring of the economy.

The analysis of composition of employment aims at identifying the proportion of workers active in sectors where the need for mobile communications is stronger. In certain countries, the proportion of workers employed in agriculture is quite high and has even been increasing slightly over recent years. These trends need to be considered when assessing the attractiveness of these countries for wireless communications

Some telecommunications indicators, such as teledensity, also show strong correlation with the penetration of wireless communications. Evidently, the need for telephone communications grows with usage and as the proportion of the consumers who benefit from phone service increases . However, one could assume that low teledensity could also be correlated with a high potential for wireless telecommunications as these evolve from mobile applications to become substitute for the PSTN. Although there is currently insufficient information to confirm this assumption, some countries with low teledensity also experience very successful penetration of wireless communications, provided that the appropriate tariff strategies are put in place. Very high usage patterns are also reported in these countries (such as >300 minutes of use per month on average per subscriber).

Assessing the potential demand in terms of subscribers and usage level within each city or county is particularly important to accurately develop network deployment plans and capital investment requirements and to support global country ide forecasts. Another key aspect of our methodology consists in developing an **index of attractiveness** for the most important cities/counties of the country to supply geographic information. This index takes into account many variables impacting the potential impact for wireless services. Among these are socio-economic variables such as population, unemployment rate, proportion of entrepreneurs and self-employed individuals, the average monthly revenues and the share of foreign investment as well as infrastructure variables such as teledensity. Those variables do not affect the demand in the same manner. Thus a high unemployment rate and low average monthly revenues should lead to a lower demand, since many companies and individuals would not be able to afford the cost of a wireless phone. On the other hand, high foreign investment is expected to be positively correlated with a higher penetration rate for mobile wireless communications.

Besides taking into account the impact on the potential demand of each of the preceding variables, the relative importance of those variables on the potential demand also has to be considered. Indeed, some variables have a greater impact on the demand than others, as is the case with teledensity over population, for instance. The index of attractiveness that results from this analysis permits us to prioritize the different cities in terms of attractiveness for wireless communications and becomes a useful tool to fine tune the network roll out plans.

The estimation of the demand for wireless communications among consumers is based on assessing the proportion of households with net monthly revenues above a pre-determined criteria of affordability. This analysis needs to take into account real gains in net income. In the case of countries experiencing rapid economic transformation, this assessment becomes critical to identify the proportion of the population which could afford wireless telecommunications at a given time and considering specific price points. Different price points are considered for fully mobile and fixed or limited mobility wireless services thereby providing valuable information as to which application promises to better meet the needs of the population at any given time.

This demand analysis sustains the split of the market between business and consumer categories and between segments within each category (such as entrepreneurs and early adopters or typical consumers). It also provides answers to the following questions:

- which market segments exhibit the most potential and where is this demand located?
- what are the most important needs of potential customers , whether they are met or unmet by the current operators?
- what are the most important components in terms of the overall cost of wireless communications which need to be successfully addressed ?
- what conditions will be necessary to foster the development of a strong market for wireline substitution for both business and consumer application?

These answers provide key inputs for operators to develop their marketing strategies and specifically their tariff strategy, depending on the market segments which are targeted. The perceived attractiveness of a market will dictate the marketing strategy to be adopted.

Another important element is the level of development or maturity of the market. Countries with very low current penetration such as Poland and Romania present very different opportunities than , for example, Hong Kong. In Poland and Romania, network coverage, accessibility and affordability are cornerstones of the marketing strategy. In Hong Kong, service and tariff differentiation are relatively much more important.

4. Impact of Wireless Communications on Universal Access

The analyses conducted by LEMAY-YATES ASSOCIATES indicate that both appropriate government policy and the demand analysis/marketing strategy are important factors impacting the potential of wireless communications to improve the availability of telecommunications services in developing countries.

Network deployment costs are evidently also a critical factor impacting the deployment of wireless telecommunications. Up to now, the cost structure of cellular has been too high to enable operators to provide direct substitutes for wireline telephone service. This is especially true in countries with low GDP per capita and also very low wireline telephone rates as is often seen in Eastern Europe[2] . These parameters dictate which options can be pursued to provide some form of telephone service in underserved areas. Wireless payphones are one solution experienced or planned in some developing countries. Another options is to introduce limited mobility services with tariffs specifically designed to enhance accessibility but still substantially higher than the wireline tariffs of the incumbent wireline operator.

Other options include wireless local loops technologies. According to reports from the United Kingdom[3] , Ionica estimates that its cost to pass a home is around £10 and that the cost to connect a home will eventually fall to approximately £300. This is below the cost per subscriber of traditional copper pair architecture. However, in many countries, the revenues necessary to support this level of investment still exceed the discretionary income of most households with respect to communications services. Therefore, an additional conclusion of our analyses is that the impact of wireless technologies to provide universal access will be tempered by the cost decreases of wireless technologies and by the growth in real income experienced in each country.

In closing, we would like to comment on the foreseen potential of wireless communications to replace wireline telephone service in developed countries such as Canada. In countries where wireline networks are fully developed and of good quality, it is believed that substantial improvements to wireless technologies will need to be achieved before wireline substitution can become a real issue. Improvements are needed in the areas of reliability, clarity of voice transmission , convenience of use (for example, still much longer battery life) and functionality . Significantly reduced call minute charges or even evolution toward flat rate pricing in some circumstances are also necessary for usage on wireless networks to increase and become comparable to what is experienced on wireline networks. Major improvements of each of these parameters coupled with the recognized advantages of mobility could however position wireless communications as strong contenders over the medium to long term.

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[1] Four PCS operators have been licensed in Canada and are expected to initiate service in late 1996 and 1997. Two of the four operators are affiliates of existing analog cellular operators and two are new players in the market. Penetration rates of wireless communications in Canada should increase over the next few years if Canada conforms to the experience of other countries.

[2] For example, current monthly expenses for telephone by Romanian households are below $5 US for local and long distance communications.

[3] "The economic impact of the use of Radio in the UK", Prepared by NERA and Smith System Engineering Limited for Radiocommunications Agency and OFTEL, 1995.

Hybrid Services: Strategic Alliances, Emerging Technologies and the Changing Global Telecommunications Market

A. Joel Eisenberg, CEO, International Telcom Ltd.

The global telecommunications marketplace is estimated to be as large as $1 trillion dollars per annum in 1996. This includes the $500 million in international telecommunications estimated by the ITU. But it also includes a variety of new technologies that are not using traditional telephone lines to connect the human race around the planet. In the past five years, there has been an explosive growth in hybrid technologies that are allowing people to communicate – by voice, fax, email and even by video transmission – with techniques that have been utterly unforeseeable to governmental regulators. Companies and even industries have been subdividing and recombining in heretofore unimaginable ways. Technological advancement has created opportunities for companies in non-traditional markets. The invisible hand of Adam Smith seems to be leading the way as different enterprises seek to exploit existing infrastructures with inventive new approaches, cross-polinating technologies in artful new combinations. East Asian countries in particular are testing these hybrids: many countries are attempting to outlaw or regulate emerging technologies in efforts to retain political and economic control. In response, young and entrepreneurial outfits are re-inventing the telecommunications industry outside of its traditionally defined parameters.

There have been numerous developments in the past couple of years. Telephone companies are now wiring with the intent of eventually providing multiple services, including cable TV and internet access. Most of the major telephone companies have started providing internet access to residential customers just to keep their foot in the door. Cable companies have their sights on the lucrative telephone market. In Germany, their is even a railroad company that, using its terrestrial network of rails, is laying new fiber-optic backbone to enter the telecommunications market. Hybrid services of all kinds are abounding; many are Internet-based, others are using imaginative applications of other technologies.

The Internet is the single largest force behind many of these innovations. It was originally designed a low-cost public packet-switching network to provide defense contractors, government agencies and universities a method of sharing data. The very nature of the Internet - a public network based on forwarding data through private servers - means that it is rather more organic than hierarchical. Its growth and direction can be controlled no better than its organization. Indeed, the finest fruits of the Internet are probably the result of this inchoate character. Email and Usenet groups were the first obvious uses of the Internet, the first "killer apps". The advent of the World Wide Web has created a medium that might be likened to static, interactive television, where the emphasis is on graphics and the choice is up to the viewer. As much as one's first glimpse of the Web may seem astonishing, we will probably look back on 1996 much the same way we look back on television in the late forties, with the small black and white screens, vertical and horizontal controls, housed in boxes the size of washing machines. Can Internet TV be far behind?

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Advances in Internet technology are changing the way we live and do business with each other. The Internet is perhaps the best known, or at least the most publicized of the new technologies that are available today. Other forms that are revolutionizing the telecommunications industry are ISDN, X.25, frame relay, ATM, and digital cellular. None of these are exactly new technologies, but they are being utilized in new and novel ways that are creating entire new markets, given their ability to provide a given service at a fraction of the cost using traditional methods.

The first sign of the primacy of the Internet is its sheer size. Estimates of the number of users vary widely, but worldwide the number is probably well in excess of 100 million, and with the number of host computers doubling every year since 1970. Email usage has already surpassed the U.S. Postal Service by a factor of five - over one trillion email messages in 1995 versus 180 billion postal deliveries.

The most obvious hybrid technology that is emerging is Internet telephony, or the use of the Internet for voice communication. There are several companies exploring this alternative, and several telephone companies that are worried by it. Expanding Internet bandwith is making these ventures increasingly viable. Netphone and Digiphone are two prominent enterprises exploiting these opportunities. While current adaptations of the Internet for voice communication are crude, allowing conversations similar to ham radio, they are also improving rapidly. The principal drawbacks at present seem to be the cost of the hardware and lack of software standards: termination points need have similar software in order to communicate, and a multimedia computer is still, at $3,000, about 300 times the cost of a simple telephone.

Other companies are addressing these issues still. Why base Internet communication on computer terminals? Net2Phone is a product that uses a computer to address the Internet, but can reach a regular telephone directly. This is a neat trick, but at 10¢ per minute in the U.S., it hardly represents an improvement over MCI or Sprint. Another firm, Labs of Advanced Technology International, recently announced Latcall, which removes computers from the process entirely to connect two ordinary telephones directly over the Internet.

There are a host of other firms that are vying for the internet telephony market, using a variety of schemes. Some require PBX adaptations for corporate use. Others are simply software applications that digitize sound to send it over the network. Many are kludges. The consumer benefit will eventually be clear, however: to allow people to interact by voice while using their computers will make many projects involving multiple people much easier to coordinate and complete.

Another interesting use of Internet resources is radio transmission, pioneered by a Seattle-based company, Progressive Networks with their product Real Audio. While Real Audio is not limited to just radio transmissions - it is primarily a means of transmitting sound over the net - that seems to be its primary application of the moment. But the market for it may eventually expand a radio station's audience to include devotees around the world. An expatriate Houston businessman in the Middle East can now enjoy Oilers games over the net at will, and is no longer dependent on the Armed Forces Services Network to broadcast the games over shortwave bands.

Probably the most interesting manifestation of Internet telephony is videoconferencing, which is being pioneered by CUSeeMe, a development of Cornell University. The picture, at about 2 frames per second, is jumpy, and the sound quality only marginally acceptable. At present, the software uses proprietary compression/decompression systems to overcome bandwidth obstacles, and seems more of an Internet novelty than a true market niche; the technical aspects of connecting two computers are too daunting for any but the most seasoned internet activists: finding and installing the software, finding someone to call, setting a time to make the connection: successful connections require a combination of luck, timing and technical skill that is beyond the casual user.

Innovative hybrid solutions using the Internet are showing up in other areas. Faxaway, a service of International Telcom, an established international telcom based in Seattle, is combining an Internet node with a telephone switch to create an email-to-fax gateway. Email is sent to the Faxaway server using the telephone number as the address, i.e., 1.206.286.5233@faxaway.com, where the image is rasterized, the fax number parsed out of the address, then forwarded through telephone lines to the appropriate fax machine. The advantage of arrangement, especially when sending a fax to the U.S., is that it becomes a domestic call, essentially bypassing international telephone lines, in a similar manner to Netphone's operation. The next incarnation of the concept is eliminating the need for email, using a simple utility to send any open document on the computer to a fax machine over the Internet. There are at least four other companies exploring similar approaches.

The opposite approach, sending fax to email addresses, is also being explored. At least two companies, Jfax and Digital Media have been developing applications that take a fax transmission, and using OCR technology, read the intended address of the transmission and forward it to the appropriate email address.

These approaches use existing email clients as the primary vehicle for transmission over the Internet, but there are other methods in development. Dedicated software clients that will fax over the Internet directly from a primary application, much like WinFax or Faxcilitate, are also in development. New networks of Internet nodes devoted to fax traffic are being developed by at least three different companies. These will allow international fax transmissions to be sent no incremental cost over the initial connection to the Internet, or at least no more than the cost of a local telephone call.

Many of these services are dependent on the availability of adequate bandwidth in order to operate at acceptable levels. These concerns are being addressed in a variety of ways, but mostly outside of the traditional telephone industry environment, which historically has exploited compression/decompression techniques to improve line speed and sound quality. Many of these are incompatible with or insufficient for Internet applications. ISDN connectivity, which has been slow to win commercial acceptance in the U.S., offers an improvement to 128 kilobits per second, a vast improvement over the 28.8 kbps available to most home users, but not nearly sufficient for smooth video transmissions. Current T-1 bandwidth allows for 1.54 megabits per second. Cable modems, designed to take advantage of the coaxial cable installed in most customers homes, may permit speed up to 30 megabits per second, and starts to realize a speed that acceptably competes with NTSC broadcast TV. It is estimated by one high-tech consultancy that there may be 7 million cable modems installed by the end of the millenium, their comparatively high price notwithstanding; many industry pundits think this number to be low. Companies aiming to exploit the market for broadband access, most notably @Home, are hoping to enter a market eager for true video-on-demand, interactive television, high-resolution video conferencing, multi-media programming and educational resources.

Bandwidth bottlenecks are being broken from both ends. While accessibility is

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improving for customers, it is also improving on the Internet itself. Internet bandwidth has been growing at the rate of 72% per year since 1970, and the trend continues. Currently, maximum speed on the internet runs at 45 megabits per second; there are plans to upgrade this to 622 megabits per second by the end of 1997. As long as a primary industry assumption holds true - that consumers will be receiving considerably more information than they will be sending - then hybrid assymetric conduits to the end-user will flourish. Economic incentives to provide this bandwidth are less clear; in all probability, localized fixed access rates will be replaced by volume-sensitive models that account for peak demand variables.

The Internet is clearly the topic of the day in the telecommunications industry, but other technologies are also being developed to supplement or supplant existing telephone systems. Frame relay, X.25 and other technologies are being used to create private international networks that almost completely bypass the major carriers except for regional routing.

The international callback industry - long known for its ability to advantageously exploit technology with true entrepreneurial spirit - has created other markets for hybrid technologies. Inherent inconveniences in the use of callback deterrs many potential customers from utilizing such services, despite the potential savings. Callback companies have learned several tricks from their Internet brethren. It is now possible to trigger a callback by sending an email, thus preventing local PTTs from blocking trigger numbers or otherwise harrassing callback users. Corporate clients, never enamored of callback's inate slowness and inconvenience, have the option of signaling through an X.25 network. The signal generates the callback and simultaneously sends the destination call through, substantially decreasing the call set-up time required, thus creating a product for callback companies that can seriously compete with local telcos in countries where it is legal.

Of course, local telcos, PTTs and government ministries are not making all of this easy. Much of Asia has already embraced the Internet and its attendant new technologies, but the traditional autocracies are creating new roadblocks. As with other emerging communications systems, many of these are simple to circumvent. China is effectively creating its own intranet, limiting access to the external network and thus the potential of "spiritual pollution" of its people. Myanmar has banned networked computers entirely. Singapore is setting up mirror sites on the island itself, which are apparently designed to filter out offensive material – how they imagine to collect all or even a portion of the world's web sites on local servers is mind-boggling, however. (Curiously, Singapore is still allowing complete unfettered access to corporations with their own network connections.) All of these impediments are eminently surmountable. Mostly, these efforts will effectively prevent competitive development of related technologies and create yet another gulf between East and West. Indeed, some hybrid technologies remain too arcane for government regulators to follow: callback services are illegal in China, but Internet-based services such as Faxaway's email-to-fax system remain beyond criticism.

Regardless of the technologies that are being utilized, the message to the major telephone companies and government-owned PTTs should be clear: there are myriad ways of competing in a cost-effective and efficient manner that are leaving the major telcos and PTTs vulnerable in unpredictable ways. Technological advancements will always be two moves ahead of government regulatory agencies. Independent and technologically savvy entrepreneurs will always be able to anticipate and sidestep regulations that impede the development of the global telecommunications markets in ways that will always mystify and confound national monopolies. The lesson of these new upstart enterprises to the major international carriers and PTTs should be clear: as the national boundaries disappear or are rendered ineffectual, global telecommunications is becoming a perfectly unfettered marketplace where the invisible hand will rule.

Information Systems and Competitive Advantage in Telecoms : Strategic Partnerships as a Determinant of Success

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1. Introduction

1.1 Overview

It has become common wisdom amongst telecommunications operators that have experienced significant competition that information systems and particularly software, are pivotal to delivering competitive advantage.

Traditionally, established telecommunications operators have sought to be self-reliant in Information Technology, establishing large IT divisions and undertaking the bulk of their systems development in-house. Their relationships with major suppliers of computing and network technologies typically were based on commodity purchasing methods, with price being a major determinant of choice.

The end result of this approach has been a proliferation of suppliers and a wide range of equipment, with support and maintenance costs added to by incompatibility.

With the advent of de-regulation and competition, both existing and new operators have moved to rationalise suppliers and equipment, in order to improve internal productivity, reduce operating costs and dramatically speed up time to market. In doing this, some operators have sought to establish new relationships with selected key suppliers, relationships that expect the suppliers to add real value to their business. However, as all the operating technologies are reduced to commodity levels, competition is based on providing excellent customer service.

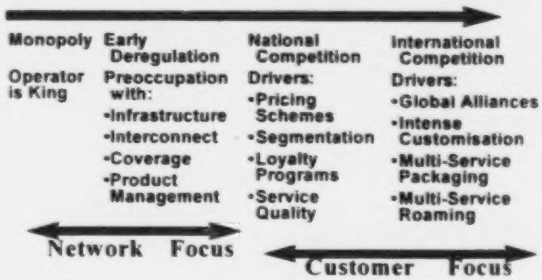
Monopoly
Operator is King
Early Deregulation
Preoccupation with:
•Infrastructure
•Interconnect
•Coverage
•Product Management
National Competition
Drivers:
•Pricing Schemes
•Segmentation
•Loyalty Programs
•Service Quality
International Competition
Drivers:
•Global Alliances
•Intense Customisation
•Multi-Service Packaging
•Multi-Service Roaming
Network Focus
Customer Focus

Fig. 1: *Focus shift to meet competition*

1.2 Purpose and scope

The purpose of this paper is to highlight the benefits of a well-architected, flexible and competitive information system that support key investment and operational business objectives, especially the delivery of excellent customer service.

The paper examines the importance of systems in achieving competitiveness that can be sustained over time, explores the ways of purchasing systems from both a customer and vendor perspective, looks at the process of establishing and operating strategic partnerships with key vendors and assesses the impact on business performance.

The key proposition is that IT architecture needs to be driven by the business imperatives, to enable the information systems to both support and contribute to the achievement of not only the operational objectives of the management but also the financial objectives of the investor. Traditionally, the management focus was driven by engineering and technology considerations. In the competitive environment, the management focus must be on delivery of excellent customer service, in order to achieve the financial objectives.

From a perspective of extensive IT partnering experience both in Oracle and in their previous careers, the authors present the view that telecommunications operators who establish strategic partnerships with key vendors who bring extensive industry experience to support their technology, will be the ones who will achieve the greatest success in the shortest time-frame, at the expense of those who cling to more traditional approaches.

The paper supports the authors' propositions by drawing on Oracle case studies in Malaysia, the Philippines, New Zealand and Indonesia; and finishes by drawing out some of the key lessons offered by the case studies.

1.3 Key issues

Systems are supposed to provide cost reductions, efficiency, speed of competitive action or response on product and price offerings, process improvement and integration, improved internal and external communication, improved billing, fraud and credit control and a host of other benefits which all contribute to competitive advantage.

However, experience shows that there are four areas that any new systems approach needs to focus on:

- The ability to not only respond to competitor activity but also to pro-actively set the market pace.
- The ability to incorporate new systems requirements flexibly and rapidly.
- A cohesive systems architecture that will support the business objectives as they change over time.
- Integration of all systems to enable the business to be truly customer responsive.

As already proposed, strategic relationships with key vendors, where the business issues are tackled by both parties and business solutions end up as joint outcomes, is the most assured way of successfully addressing these four.

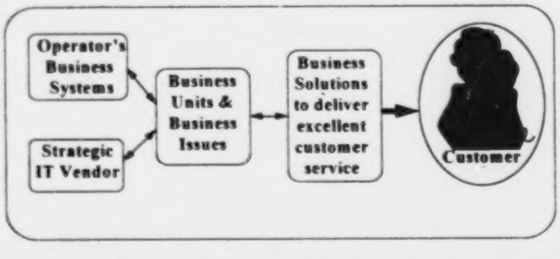
Operator's Business Systems
Strategic IT Vendor
Business Units & Business Issues
Business Solutions to deliver excellent customer service
Customer

Fig. 2: ***Strategic relationships and excellent customer service***

2. The Importance of Information Systems in Sustainable Competitiveness

2.1 Impact of competition

The impact of competition on the information systems of telecommunications operators is profound. Systems that are a hindrance to flexibility and which lock the operators in to unchangeable processes, are no longer acceptable. However, too many even new operators have found themselves trapped by their systems and unable to meet competitive demands.

2.2 New systems approaches and requirements

The operator's business focus need to shift from the traditional network-centric model to a new customer-centric model. The achievement of a truer customer focus requires integrated business processes that are enabled by integrated information systems, lots of data, the ability to access required data, and the availability of a single consistent view of the customer. Key functional systems are customer care and billing, data warehousing, an integrated front end, and creation and activation software for the advanced services associated with the intelligent network.

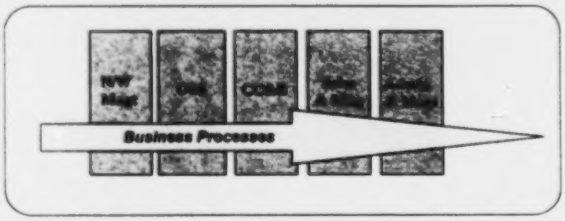

Fig. 3: ***Integrated business processes***

2.3 The fundamental importance of a good systems architecture

In order to remain competitive, telecommunications organisations are increasingly being required to support flexible and changing business processes and to reduce the costs and limitations imposed by diverse application and technical architectures. Information needs to be shared both within an organisation - between marketing, customer service and networks for example - and increasingly outside it, with customers and partners both world-wide and nationally.

In order to begin to achieve this, a unifying 'map' is required upon which standards can be built, quality can be assessed and improved, and the seemingly complex mass of available data can be managed and understood for business advantage.

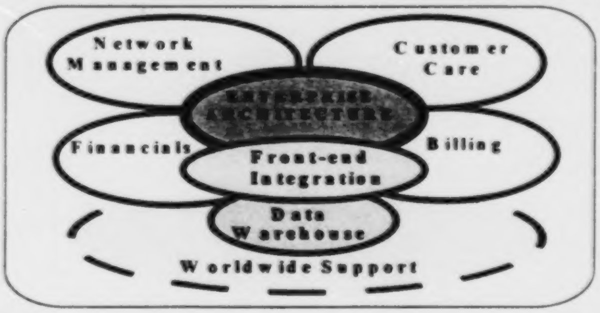

Fig. 4: *Core Architecture components and tools*

An Enterprise Data Model provides a business-wide view of the key information items required by all user groups in order to operate a competitive business. The Enterprise Data Model is the most critical component of the Information Architecture.

The Enterprise Data Model may be used to provide:

- A basis for the common definition of terms, ideal information structures and common interface definitions that can be used to reduce integration problems.
- A starting point to develop standards for data exchange with other operators, for example, inter-carrier settlements.
- A common start point for new projects in terms of analysis or definition of requirements. Hence as more projects use and enrich the common model, this facilitates the move towards improved systems and data integration.
- A basis for the design and scope of Decision Support Systems (DSS) and Data Warehouses.
- A means by which experienced Business Analysts can facilitate a dialogue with Senior Business Users on current industry issues and future requirements - without the need to resort to a 'blank sheet' top-down analysis.
- A definition of information to be managed by each application making up the OSS that can also assist the implementers of packages by helping to define installation parameters.
- The model may also be used as a basis for specifications to suppliers and to assess the degree of fit of package based solutions.

2.4 Integration - the key to customer responsiveness

Efficient business processes, execution of competitive strategic intent, and fast competitive response, are only possible when information systems are integrated. Application, technology and especially information architectures are key to this integration.

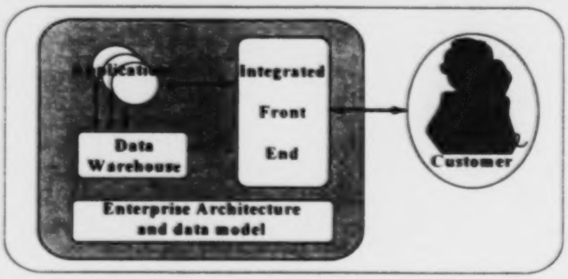

Fig. 5: *Integration - key to excellent customer service*

3. The Old Way of Managing Systems and Suppliers

3.1 Traditional Approach

Traditionally the operator's IT department adopted an arms length, tendering, price oriented approach to the acquisition of IT applications. This approach did not enable the operator to benefit from the suppliers' experience as all input came from internal staff who tended to adopt a "we know best" prescriptive approach which excluded supplier input.

This generally resulted in a number of disparate point solutions that were difficult or impossible to integrate, with little process integration that did not meet end user requirements. The various applications held the same information in different formats with no common data definitions and relationships, resulting in duplicated and inconsistent information and functionality. Consequently the systems were slow to respond to changing customer and business requirements, resulting in loss of market share by former monopoly operators to new operators.

3.2 The buyer perspective

As markets deregulated, existing operators found it difficult to respond to the following pressures:

- To enhance customer service by empowering customer facing staff with greater knowledge of customers and their product usage, to better serve customers at the first point of contact.
- To support process improvement.
- To make data that is consistent and accurate available throughout the organisation in a timely manner.

- To drive down costs through the use of IT to enhance the productivity of front office staff and to reduce rework levels at all points in the service delivery process.
- To reduce IT development and operational costs.
- To reduce the time to market for introducing new products and services.

3.3 The vendor perspective

Vendors on the other hand felt that they were being forced to fight with one hand tied behind their back because of the following:

- The adversarial relationship that tended to exist with their customer, the IT department.
- The inability to get to understand the business issues and requirements first hand through direct interaction with end user areas without them being "filtered" by the IT department, resulting in numerous change requests and associated cost overruns.
- Suppliers were restricted to supplying components on a commodity basis because of the emphasis on price based competitive bids. This precluded the operator from benefiting from the suppliers experience.
- The focus on inputs rather than business outcomes.

3.4 Major problems

The IT department is necessarily involved in responding to the above-mentioned pressures resulting from increased competition. However, their inability to respond quickly enough often left them open to receiving an unfair share of the blame, resulting in pressure from business units for radical solutions such as outsourcing.

Consequently, the old ways of doing business could no longer be sustained in a competitive environment because of:

- Cost blow-outs.
- Frustration by all parties (business units, end users, IT department and suppliers).
- Failure of IT to deliver the required business benefits.
- The gap between 'current reality' and 'worlds best practice'.
- Budget caps putting a downward pressure on IT budgets.

4. The New Way of Managing Systems and Suppliers

4.1 Key elements

The key elements of the 'new way' involve the customer:

- Addressing the 4 key issues (competitive stance, rapid and flexible new systems, cohesive systems architecture, integrated systems).
- Recognising the value of the vendor's contribution.
- Enabling the vendor to participate in problem definition as well as solution design.
- Benefiting from the vendor's experience.

Involve the vendor:

- Adding value to the operator's business.
- Sharing ownership of the business problems.
- Investing in the relationship.

Plus both customer and vendor sharing:

- A long-term perspective of the relationship ***(typically 3-5 years or more)***.
- Both the risks and the rewards.

4.2 Creating strategic partnerships with key vendors

From the authors' experience for a vendor to qualify for selection as a strategic partner they should meet the following criteria:

- Market credibility.
- A proven track record with customer reference sites.
- A demonstrated commitment to support open standards.
- Proven technology (leading edge not bleeding edge) with adequate local support
- Investment in research and development to adequately support future evolution of their technology.
- Ability to add value to the client's business and the clients existing IT investment.
- Relevant industry experience.
- Ability to work with the client on a win-win basis with no hidden agenda
  - Open management style (no surprises).

5. Case Studies of Successful Systems Partnering

5.1 Malaysia - Binariang

5.1.1 Background

Binariang Sdn Bhd is a recent entrant into the telecommunications market in Malaysia with licenses to provide cellular (GSM), fixed local and long distance, international gateway services, and enhanced services including internet access and cable TV delivery. Binariang operates under the Maxis trade name. Binariang's sister company Measat is the owner and operator of Malaysia's national satellite. Binariang is 20% owned by US West and 80% owned by local Malaysian interests. US West has operating control of Binariang under the current shareholders agreement.

Binariang commenced the operation of its GSM services in July 1995 and its fixed network services in February 1996. Binariang's systems are architected to support more than one million customers.

5.1.2 Vendor Policy

The policy of the US West IS management team in Binariang was to select a limited number of vendor organisations as strategic "vendor-partners." Oracle was invited by Binariang to establish this relationship early in 1995 during the business start-up phase.

5.1.3 Binariang's IT Strategy and Architecture

Binariang has implemented an IT strategy which wherever possible involves:

- Standardising on DEC Alpha hardware platform for both clients and servers.
- Standardising on the UNIX operating system.
- Adopting a buy rather than build strategy with regard to software applications.
- Standardising on the Oracle database management systems.
- Using the Oracle Designer/2000 and Developer/2000 tool-kit for software development.
- Using Oracle Method, customised and enhanced for Binariang as a methodology standard.

Binariang's current application architecture has a number of key components:

- Core financials and business support systems based on SAP.
- Core customer billing functions are based around the LHS BSCS product.
- In-house development (by Oracle) of Service Order Management systems.
- Sales support and marketing systems using the Brock package from Cocam.
- Network management systems are being installed based on a GTE package.
- Roll-out of key Customer Care and Billing application components (Order Management Releases 3 and 4) to support the introduction of CATV and VOD services and other advanced broad-band products.
- Improved software development cycle and system quality by fully implementing Oracle Method and an Information Architecture framework.

5.1.4 Partner Deliverables

In its role as a "vendor/partner," Oracle has undertaken a number of projects at Binariang, including:

- Participation in the development of Binariang's initial application architecture, and various reviews of this architecture as it has evolved.
- Participation in specification of requirements for fixed network billing and customer care, and evaluation of package applications.
- Evaluation of the feasibility of extending the LHS BSCS application package as a "black box" for fixed network and other multi-service billing. This included a detailed architectural analysis of the rating engine of BSCS to determine its suitability. The outcome was a decision to extend BSCS.
- Provision of a DBA manager and other technical support and systems management staff to assist Binariang with meetings its staffing needs.
- Development of Binariang's Enterprise Data Model, based on Oracle's Telecom Reference Data Model, and application of this Model to Binariang's integration and information management requirements.
- Implementation of Oracle Method including its sub-components as the basis for "Maxis Method".
- Development and ongoing review of Binariang's "Customer Support Systems Applications Architecture".
- Integration of the Service Order Management System, the BSCS billing system, ICRE inter-carrier settlement system, Brock marketing system, SAP finance system, ATACS Fraud management systems, call event record collection system, and service provisioning system.
- Delivery of the Service Order Management System Release 1.0.
- Fixed price turn-key delivery of Service Order Management System Release 2.0 and 3.0. (Releases 3.1, 3.2 and 3.3 are currently planned).
- Various other small bespoke design, development and integration projects as required.

5.1.6 The importance of the Enterprise Data Model

The Binariang Customer Support Systems (CSS) application architecture is based on a close data integration upon which a 'building block' functional architecture can be layered. This approach combines purchased application packages (eg. LHS's BSCS package) along with custom developed systems and sub-systems. The architecture will evolve by isolating the functional building blocks with well-defined interfaces, whilst continuing to evolve a single logical data model, which in turn is physically implemented with a minimum amount of data replication. This will allow Binariang over time to enrich its CSS functionality either by adding to existing building blocks or completely replacing them.

The success of this CSS functional architecture is dependent on the Enterprise Data Model (EDM). The linkage and integration between the tactical data models Binariang are using in a custom development and those in application packages, and the strategic framework EDM, ensures a common understanding of Binariang's overall systems architecture. Apart from the integration benefits this provides in the Operation Support Systems arena, there are additional benefits provided in the decision support area.

5.1.6 Customer Outcomes

The result for Binariang of this close relationship with Oracle has been to create a single integrated systems environment to support Binariang's multi-service multi-market business. This has been created quickly at relatively low cost, and by avoiding most of the normal pitfalls of new operators rushing to establish systems, Binariang have created one of the most flexible and competitive support systems infrastructures in the industry. This approach is also providing Binariang business units with certainty by delivering applications on time.

Following this approach has allowed Binariang to manage the rapid growth and change it foresees in its business, providing the close integration which will support delivery of new services to market within short time frames, and allow it to enrich functionality over time as its customer base matures and demands more sophisticated products and services.

5.2 Philippines - Bayantel

5.2.1 Background

Bayantel is a telecommunications holding company for its subsidiaries, ICC Telecoms, NAGATEL, EVTELCO and RCPI. They began their fixed line service early in 1996, and since then, have successfully achieved significant marketshare with their international gateway.

The Philippines has one national backbone that is owned and operated by former monopoly PLDT. However, there is a move, being led by Bayantel, to lay the next national backbone for the Philippines, which is currently being considered by the government.

Bayantel is also building a full-digital network infrastructure in their franchise areas, Quezon City, Malabon and Valenzuela. This is an FDDI/ ISDN/ATM ready network. Bayantel is currently running a pilot project on Frame Relay, which it will soon deploy.

5.2.2 Vendor Policy

Bayantel's policy has been to select a small number of vendors to provide its core systems. Oracle was selected to provide the database and design and development environment, and to support Bayantel's custom developments. Bayantel also chose Oracle Financial software for business management and this is being implemented by Oracle.

5.2.3 Bayantel's IT Strategy and Architecture

Even though their business partner, NYNEX, was in favour of a mainframe-based information system, Bayantel has implemented a client/server computing system, with Oracle acting as the information engine.

Bayantel has also:

- Adopted a build strategy, using Oracle technology, to satisfy the unique requirements of their Customer Care, Directory and Billing Systems.
- Standardised on a Digital 8400 hardware platform.
- Standardised on the UNIX operating system.
- Integrated Oracle Applications and OLAP with the company's core information systems.
- Developed a data warehouse strategy using Oracle technology that will integrate the data from all of the subsidiary companies.

5.2.4 Partner Deliverables

Oracle's deliverables at Bayantel have been:

- Database software, design and development tools.
- Architecture, design and development support for the customised billing and customer care system development.
- Oracle Financials software, installation and commissioning.
- Initial design for a customer data warehouse.

5.2.5 Customer Outcomes

Bayantel were able to develop and deploy the initial release of their Customer Care and Billing System within one month, using Oracle technology, and the industry knowledge and expertise of its partners, Oracle and NYNEX.

Bayantel has introduced a new standard in telecommunications within the Philippines. Subscribers need no longer wait for years to get a telephone connection; Bayantel delivers a line to the user within a week.

5.3 New Zealand - Telecom

5.3.1 Background

Telecom New Zealand is the major full service operator in New Zealand's highly deregulated telecommunications market. Although now privatised Telecom was the former monopoly operator prior to 1989.

In May 1996, Telecom New Zealand confirmed Oracle as the prime vendor for delivery of its Proactive Business Enablers (PROBE) and Customer Sales and Service (CS&S) systems. These marketing and customer service systems are part of a huge effort focused on re-engineering the front end and support processes of Telecom's residential and business sales channels.

5.3.2 Telecom NZ Drivers

Both CS&S and PROBE are critical to Telecom's success and competitiveness. The key competitive issues being - time to market, improved service and customer segmentation, revenue enhancement, cost reductions, performance measurement and future proofing the business.

Telecom has recognised that a strategic relationship with a key vendor like Oracle is the vehicle to successfully achieving Telecom's business imperatives through:

- Embracing a business process orientation, focusing on continuous renovation/innovation of business activities to deliver total quality and maximum value to the customer.
- Being flexible enough to accommodate frequent and extensive change.
- Radically enhancing Telecom's ability to quickly respond in the market place.
- Empowering Telecom's customers to meet the demands for greater control of their work/service domain.
- Being cost effective.
- Using new technologies as strategic weapons.

5.3.3 Customer Sales and Service (CS&S)

The CS&S project is focused on re-engineering the Sales and Service Delivery processes for Telecom's core Residential and Business Customers, and to contribute to improved end to end customer management.

The CS&S vision is for a "two person" model involving the initial contact with the customer by the telephone representative and a single visit to the customer by a field force person. Where possible this service is to be provisioned and activated automatically, on-line, by the telephone representative.

The sales vision is to be both responsive to the customer, through identifying sales solutions and anticipating needs, and proactive with the customer through customer intimacy.

For CS&S, Oracle is building one of the most advanced OLTP systems deployed in the region, using the Oracle7 RDBMS and associated development tools plus Tuxedo TP monitor. This tired architecture approach is required to support thousands of front-line concurrent users and representatives.

5.3.4 Proactive Business Enablers

PROBE is a Data Warehouse that provides timely, easily accessible, customer intelligence information to enable and drive superior marketing and business decision making.

The Warehouse is being built using Oracle's core database technology, development tools and end user reporting tools to provide customer information and intelligence. In addition Oracle will be developing a number of PROBE applications to support the CS&S vision.

The PROBE Data Warehouse will contain hundreds of gigabytes of up-to-date customer data, sourced from existing Telecom legacy systems and external agencies.

5.4 Indonesia - PT Telkom

5.4.1 Background

PT Telekommunikasi Indonesia (Telkom) is Indonesia's domestic local and long distance fixed network operator. Telkom is also a shareholder in most of Indonesia's international, cellular and value added telecom operators. In 1995 foreign investors were introduced to the Indonesian domestic telecom market through the "KSO/Joint Operating Scheme". PT Telkom underwent a partial privatisation late in 1995, with public listings on the Jakarta and New York stock exchanges.

5.4.2 New Systems Approach

Telkom has chosen to standardise on the Oracle database for its new systems acquisitions and developments. Commissioning of a new Oracle based customer care, billing and network management system based on the "Girafe" software from France Telecom is now underway. Telkom is also planning a complete new MIS environment that will use the Oracle database.

In the first half of 1995 Oracle undertook a complete systems review on behalf of Telkom. In this review Oracle examined Telkom's then existing information systems and the business and systems issues and needs that would result from the introduction of the KSO operators and from Telkom's partial privatisation. Oracle recommended an application architecture for Telkom, as well as system priorities and integration requirements. This study was undertaken by Oracle as part of its commitment to its partnering relationship with Telkom.

The main benefits to Telkom from this strategic partnership with Oracle have been:

- Standardisation on database technology has delivered cost efficiencies through having staff trained on supporting one database environment.
- An ability to leverage off the vendor's global experience with other telecommunications operators that have undergone similar changes.
- Assistance from the vendor with identifying systems requirements and architecture for the post IPO/KSO environment and with progressing towards implementing these recommendations.

6. Summary and Conclusions

6.1 Making the partnerships work

The Client/vendor relationship will evolve over time as depicted in the following diagram, from responding to tenders through to joint venture. The better the fit the shorter the time frame to move from right to left through this continuum.

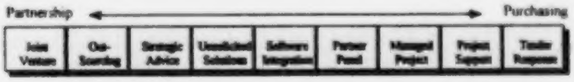

Fig. 6: ***Relationship Model - Continuum***

There are three primary dimensions to the working partnership model - attitude, objectives and process.

6.1.1 Attitude

The relationship must be based on a prevailing attitude of real trust, sharing of risks, rewards and information - and even ownership of intellectual property - along with an approach that sets long-term value above simple price and clear recognition of the value that each side contributes. The traditional customer-supplier relationship mitigates against this, with its arms length, adversarial and information poor approach, all of which limit the vendor's ability to properly serve the customer's real needs.

6.1.2 Objectives

While the primary objective remains to enable the customer to achieve or exceed its business objectives, it must be recognised that this is best done through the customer also taking due account of the needs for the vendor also to achieve its' business objectives. Thus, the really successful relationships will not only be based on a win-win philosophy, but will have this clearly stated as one of the primary objectives of the relationship.

6.1.3 Process

There are two aspects of process - management and the sharing of risks and rewards.

Management:

Management of the relationship will occur at three distinct levels:

- Program, where the overall direction and review of the relationship takes place. This is best done through a joint management group, with one member from each party nominated to handle day-to-day liaison.
- Initiative, which focuses on detailed joint direction of major projects or activity areas.
- Activity or Project, where joint teams will be engaged in specific projects, under the leadership of a project manager drawn from one side or the other, as appropriate.

From the authors' experience, there are two key aspects of this process that enable or deny success. The first of these is the ability to successfully mix and match management and staff from both sides, creating cohesive teams that maximise the underlying synergy that made the relationship make sense in the first place. The second is a continuing need not only to communicate the rationale for the relationship - and its nature - to all participating and affected staff on both sides, but also to have this communication reinforced periodically by management.

Risk- and reward-sharing:

Frequently, the customer will seek to have the vendor (strategic or otherwise) 'share the risks'. Typically, this proposition is advanced in the customer-supplier relationship and is just as typically not greeted warmly. However, where the vendor is given access to adequate information and understanding of needs and objectives and, most importantly, the longer term perspective provided by a strategic relationship, it is able to consider quite seriously sharing up-front investments and even agreeing to payment based on results.

One way of reward-sharing that is now gaining more currency is the ceding of intellectual property in the solution to the vendor. This enables the vendor to replicate the solution for other customers, thus reaping a competitive and commercial advantage. The royalty payments to the original customer, occurring over time, go somewhat towards offsetting the original costs and can be returned to the business by being directed towards future project expenses.

6.2 Key lessons

The pull-through strategy exemplified by this approach is preferred by the customer compared with the traditional product-selling approach, with its focus on component sale inputs, rather than business outcomes closely linked to the operators' key business imperatives.

From the vendor perspective, this approach engenders a long-term, productive relationship based on value delivery to the customer's business, requiring the vendor to change the way it does business, the way it organises and the nature of skills and expertise that it must deploy in such a strategic relationship.

The most important skill areas for the vendor to develop are telecoms business and telecoms business systems, whilst dedicated and multi-skilled account teams replace the traditional sales units. Dealings with the customer must be co-ordinated by the individual responsible for the overall relationship, whilst much of the collaborative work with the client will be undertaken by business systems and technology consultants, rather than the traditional sales representatives. Consultative selling and strategic account management become the new modus operandi that best suits the customer's needs.

A commercial relationship that is not predicated on price-based purchasing has key and compelling advantages for both sides. It enables the customer to:

- Tap the accumulated experience of its strategic vendors in exploring solution options, rather than prescribing the solution from within its own experience and knowledge base
- Share its business needs directly with the strategic vendor, rather than have them conveyed, in a synthesised and filtered form, second or third hand

While it allows the vendor to:

- Propose the best possible solution to address the business problem
- Invest, over time, in the infrastructure and resources needed to properly support the customer needs

6.3 Conclusions

A common theme running through the case studies is that successful partnering is based on an engagement model where the vendor works with the customer in developing the business systems strategy to meet the customer's business vision and business strategy.

By being involved in development of the systems strategy the vendor is better placed to ensure that any solutions proposed will meet the customer's business requirement and result in a win-win outcome for the customer and the vendor.

Using this approach a vendor is able to share the business risks with the customer and undertake assignments on a fixed price basis, with performance criteria related to achievement of business outcomes for the customer.

A second theme running through the case studies is a focus on integration of the operator's customer handling processes, coupled with integration of the data (not only internal but also market intelligence) to support service delivery, and product and service innovation. Indicating that successful vendor partnering involves the vendor and the customer having a common external focus, namely the ultimate end customer.

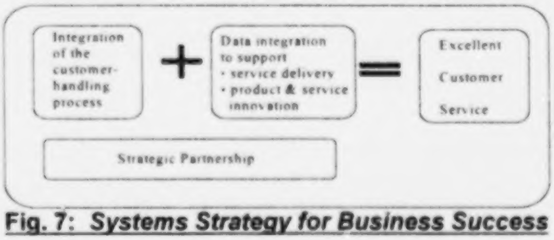
Integration of the customer-handling process
+
Data integration to support
• service delivery
• product & service innovation
=
Excellent Customer Service
Strategic Partnership

Fig. 7: *Systems Strategy for Business Success*

Strategic Alliances within the Australian Telecommunications Industry: A Longitudinal Study

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1. ABSTRACT

The notion of strategic alliances, like entropy, is much talked about but little understood (Yoshino and Rangan, 1995: 4). This paper outlines a study in progress focused on inter-firm cooperation through mechanisms of strategic alliances. The industry in question is the Australian telecommunications sector and the paper concentrates on the relationships involving the three carriers - Telstra, Optus and Vodafone - and their "first-tier" multinational partners (suppliers).

2. INTRODUCTION

The fields of strategic management and industrial organisation, in particular, have offered many analyses of strategic relationships among organisations. These, however, proide only partial answers. We need to focus less on agreements as explored in such studies than on what is critical to current organisation theory, understanding the nature of such relationships as they develop over time, plus the role played by government in fostering collaboration. Given this, the Australian telecommunications industry provides a useful site for theory testing and development because of its degree of business concentration, and the strategic relationships and networks involved.

Cooperation between firms occurs for various reasons that range from government regulation, through risk reduction, to the demands of international competitive forces. For telecommunications organisations, while there are a variety of linkages internationally, fundamentally, technological and regulatory change, along with altered competencies and access to markets required in the industry, have headed the rationale for such relationships. Indeed Naisbitt (1994), among others, maintains that the telecommunications industry for the 21st century is being created by strategic alliances and that what we will have, eventually, is a seamless, global, digital network of networks - a most ubiquitous innovation. It is this network of networks that we believe is emerging in the Australian telecommunications industry, demonstrating that it is through relationships as facilitating mechanisms that networks succeed in achieving their strategic purpose (D'Cruz and Rugman, 1994).

Importantly, the Keating Government played a role as catalyst, perhaps sometimes as 'dictator', in having industry players establish linkages, with the firm belief that we are entering an age where cooperative strategy provides a viable alternative to narrow traditional competitive strategy - a sort of competition through cooperation. Within this cooperative paradigm, the telecommunications industry has flourished (BIE, 1994). Consequently, this paper reports on the industry under such a regime, outlining part of a longitudinal study in progress, focussed on intensive interviews with industry and government representatives. Some preliminary findings emerging from this phase are presented here.

3. STUDY IN PROGRESS

The study underway aims to clarify the processes of interorganisational cooperation in the Australian telecommunications industry, initially focussing on the three carriers - Telstra, Optus, and Vodafone - and their industry relationships, particularly with their suppliers. The aims are to further develop organisational theory in the area; and assist policy processes, and government and industry practices to ensure the future viability of this critical segment of the Australian economy.

Current Australian telecommunications policy is the result of a five year period of Commonwealth government reform which has pushed the sector towards competition, globalisation, dynamism, customer-orientation, and commercialisation. In this reorientation there has been a recent emphasis on promoting organisational collaboration, including some long-term strategic relationships between the carriers and global equipment suppliers. It is envisaged that this would involve world or regional mandates in switching, transmission and network management. Benefits include the facilitating of the continued introduction of leading edge technologies and their manufacture, and helping Australian subsidiaries in attracting mandates for overseas parent organisations.

Unfortunately, such an emphasis belies the fact that we do not have adequate understanding of how such collaborative arrangements do and should work. First, there is a wide variety of perceptions as to precisely what collaboration means in both theory and practice. Second, the literature in the fields of R & D, organisation and international business studies focuses on some real difficulties in theory and practice (e.g. Parkhe, 1991; and Geringer and Herbert, 1991), including the fact that "Many strategic alliances fail" (Forrest, 1992: 25). Moreover, as Farr and Fischer (1992: 55) suggest: "it is the politics of managing, more than the technology itself, that appears to determine success or failure."

Given such difficulties and the relative paucity of local research on high technology industry collaboration, our study addresses the following key questions, principally through examining the strategic relationships the carriers have and are developing in the industry, primarily with suppliers:

a) What are the current perceptions and practices of organisational collaboration in the Australian telecommunications industry?

b) What are the longer term national and international implications for the industry given:
  i) major rationalisation among current suppliers; or
  ii) technology-driven proliferation of new niche product suppliers; or
  iii) both i) and ii) above occurring?

c) What does the study in one major industry reveal about some of the strengths and weaknesses of organisation design, management, and network theory.

d) Given the study findings, what directions should government policy take on the issue of industry collaboration in the future?

Our initial study focuses on one form of collaboration - that broadly defined under the heading of strategic alliances. Strategic alliances within the Australian telecommunications industry can be broadly classified into: 1st-tier, which involve linkages between carriers and the major international suppliers; and 2nd-tier, which involve linkages between carriers and the major suppliers with smaller indigenous firms. 2nd-tier linkages are important, particularly in relation to the Government's aims in fostering local industry, but our focus in this initial study is mainly on the crucial 1st-tier alliances.

This paper reports on one aspect of our study, based on the conduct of some 20 in-depth, personal interviews (approximately two hours each) with one or more key senior executives from the major Commonwealth Government bodies in the area such as Department of Communications and the Arts (DOCA) and Department of Industry, Science and Technology (DIST), from each of the three carriers and the major suppliers, and some key industry associations. Interviews focussed on understanding the alliance processes in terms of the pre-alliance stage (matching and negotiation), the alliance agreement development stage, the implementation stage, the ongoing process, and the costs and benefits of alliances. Future stages of the research involve a survey (by questionnaire) of industry, government, and industry association representatives and a network analysis exercise, aimed at mapping key relationships (established and emerging).

4. THE AUSTRALIAN TELECOMMUNICATIONS INDUSTRY

The changing nature and profile of the Australian telecommunications industry have been substantially affected by a range of Government initiatives and basic policy reforms. This followed recognition in the mid-1980s that Australia's communication and information industries were apparently underdeveloped in relation to their potential and growing market opportunities in the sector (BIE Report 63, 1994).

Key among Government initiatives have been those of competition introduced in general and mobile telecommunications, price controls, regulation of interconnection arrangements, and the universal service obligation (USO) (BTCE, Working paper 16, 1995). These followed the Telecommunications Act 1991 where major performance goals were clearly outlined by the Government: to foster competition, increase efficiency, guarantee social objectives (such as equity, access and privacy) were met, and to support local (particularly equipment manufacturing) industry/capabilities/skills.

In Australia the equipment market rests on transnational corporations and smaller indigenous firms. Here Government policies have proactively targeted the large transnationals local value-added activity in order to preserve, but, also importantly, to develop our own companies and their capabilities and skills. Such efforts have emerged as a result of a variety of industry initiatives to develop skills, capabilities and real technology transfer. These have occurred in the areas of carrier obligations with regard to purchase of local product, Industry Development Arrangements and the like.

Government policy initiatives in encouraging the location of transnationals and ensuring carrier industry development obligations, for example through DISTs Telecommunications Industry Development Authority (TIDA), have certainly helped industry development. The critical one for us here, however, is that of the promotion, for innovation and growth, of strategic alliances or intra-industry partnerships or links of some sort. The emphasis has been on fostering of strategic commercial relationships between suppliers and carriers in order that long term relationships with the domestic industry are developed.

5. STUDY: PRELIMINARY FINDINGS

5.1 SCOPE AND BACKGROUND

Cauley De La Sierra (1995) has divided alliance types into alliance joint ventures (new entity created), functional agreements (limited cooperation across functions), equity investments exploiting complementary strengths, broad framework pacts (broad agreements and then specific contracts). A specific contract itself can be considered an additional type. Partly because of the seeming dominance of the broad framework pact as the alliance type most favoured within the Australian telecommunications industry, we have employed this classification scheme within our study.

A-Id	Descn/Name	Partner 1	Partner 2	Type	Scope	S/P	Duration
a01	TSA	Telstra	Siemens	bfp	international	mp	7
a02	TSA	Telstra	Alcatel	bfp	international	mp	7
a03	TSA	Telstra	Ericsson	bfp	international	mp	7
a04	TSA	Telstra	Nortel	bfp	international	mp	7
a05	ADSL	Telstra	NEC	sc	local	sp	-
a06	ISDN	Alcatel	JTEC	bfp	international	sp	-
a07	OSS	Optus	DEC	bfp	international	sp	5
a08	Transmission	Optus	Fujitsu	bfp	international	sp	oe
a09	Construction	Optus	Leightons	bfp	international	mp	oe
a10	OMDN	Optus	Nokia	bfp	international	sp	oe
a11	Switching	Optus	Nortel	bfp	international	sp	oe
a12	SES	Optus	NEC	bfp	international	sp	-
a13	Base Station	Nokia	ERG	-	local	sp	-
a14	Mobile Equipt	Vodafone	Ericsson	bfp	local	sp	-
a15	Smartcards	Vodafone	Keycorp	sc	local	mp	oe

Table 1: Alliances Investigated.

The strategic alliances investigated are detailed in Table 1 above. A brief description of each table column follows. The basic purpose of each alliance is implied by the *descn/header* column (for further detail, see below). In all but two cases, *partner 1* is one of the three licensed carriers and *partner 2* is a supplier of telecommunications-related equipment or services (or, in most cases, both). In the other two cases, both partners are suppliers. An alliance *type* can be a *broad framework pact (bfp), joint venture (jv), equity investment (ei), and specific contract (sc).* The *scope* column indicates whether the range of operations is *local* (to Australia) or *international* (note that the emphasis is on operations - not on support activities, such as senior managment review and control). The *s/p* column is used to identify whether the alliance is *single* purpose or *multi* purpose. The *duration* of the alliance is given in the final column (with *oe* meaning *open-ended).* The alliance list is dominated by the four Telstra strategic alliances (TSAs: a01-a04), and five Optus strategic partnerships (a07-a11). The third carrier, Vodafone, is involved in two alliances (a14 and a15).

Telstra's TSAs arose out of a rationalisation of its supplier arrangements, as part of its Future Mode of Operations (FMO) programme (a programme, initiated in 1993, aimed at digitalisation and a major upgrade of the Telstra network, at an estimated cost of $3.3 billion). Product sourcing agreements were made with three switching suppliers (Alcatel, Ericsson and Nortel) and one transmission supplier (Siemens). These agreements and the FMO programme can be viewed as enablers for the TSAs. Specific contracts are entered into under a looser and more flexible arrangement (i.e. a bfp) than was previously the case (where equipment was tendered for and supplied on a contract by contract basis). In addition, the focus now is not only on delivery of equipment and services, but on identifying ways in which new technology can be utilised more effectively. This additional focus often leads to the establishment of cooperative projects which are undertaken within a TSA arrangement.

While most TSA activity has taken place in Australia, this is not exclusively the case. Furthermore, one supplier representative described the TSAs as "the leading edge of what is happening globally"; while another observed that the TSA model is a very advanced and sophisticated response to a rapidly changing competitive environment and that progress is being followed with great interest by the parent company. Thus, the scope of all TSAs is indicated in Table 1 as international.

Telstra is involved in many other collaborative relationships, the most recent being its high-profile, tripartite arrangement with IBM and Lend Lease. The relationship with NEC (a05 in Table 1), is of particular interest - principally because NEC is also involved in a partnership with Optus (a12) for the development, utilisation and international sale of advanced satellite earth station technology.

Offering long distance and mobile services since late 1992, Optus Communications is Australia's new general telecommunications carrier involved in fibre, mobile and satellite based communications. It is owned by BellSouth Corporation and Cable and Wireless Plc from overseas and, locally, Optus Pty Ltd (owned by Mayne Nickless, the AMP Society, AIDC Telecommunications Fund Members, and National Mutual). Optus's five key strategic partnership alliances are with: 1) DEC (a07 - development of its operations support systems (OSS)); 2) Fujitsu (a08 - provision of transmission equipment); 3) Leighton Contractors (a09 - construction work and cable laying); 4) Nokia (a10 - radio systems and mobile digitial network); and 5) Nortel (a11 - provision of switching systems).

Optus decided on the strategic partner concept essentially because it believed it would help maximise its presence in the Australian market place in the shortest possible time (e.g. time constraints were so tight that all partners were required to have equipment in Australia on the day Optus was awarded its license). Also, by effectively outsourcing most of its operations, Optus was able to take advantage of its partners' expertise, local knowledge, access to capital and the like, leaving it free to focus on what it saw as its core business (customer service). In addition, it is clear that entering into long-term strategic partnerships with companies already doing substantial business in Australia certainly did not harm Optus in its license bid!

All but one of the Optus strategic partnerships are open-ended. This arrangement seems to favour Optus since it can elect to end a partnership at any time if it believes that supplier performance is not up to "world best practice" standard. As with Telstra's strategic alliances, the scope of the Optus strategic partnerships is international. However, international objectives are clearly secondary to local Optus operations support activities. This can be seen most clearly in the Optus partnership with DEC where OPCO, the joint venture formed to develop an extremely advanced set of telecommunications information systems, has now been dissolved. DEC continues to supply Optus with information systems services, but under much the same sort of arrangement as applies to the other strategic partners.

Optus refers to itself and its alliance partners as the "Optus-Wide Collective" and does its best to promote collaborative activity between its partners and between its partners and local firms. A good example of the latter is the 2nd-tier alliance between Nokia and the local company ERG Pty Ltd, which has achieved considerable success in the design and development of innovative satellite base station technology.

The third major carrier currently operating (although restricted to cellular, mobile communications) in Australia is Vodafone, a UK-based company currently involved in two significant strategic alliances. The first of these is with Ericsson (for the supply of key infrastructure and customer handsets) and the second is with the local company, Keycorp (for the manufacture and supply of integrated circuit-based "Smartcards"). These are designated as a14 and a15 respectively in Table 1.

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A-Id	Party	ma	ca	lea	ta	csl	es	agr	rs	ii	gmc	pct
a01	Telstra		y	y	y	y	-	-	y	y	y	y
a01	Siemens	y	-	y	-	y	-	y	y	y	y	y
a02	Telstra		y	y	y	y	-	-	y	y	y	y
a02	Alcatel	y	-	y	-	y	-	y	y	y	y	-
a03	Telstra		y	y	y	y	-	-	y	y	y	y
a03	Ericsson	-	-	y	-	y	-	y	-	y	y	y
a04	Telstra		y	y	y	y	-	-	y	y	y	y
a04	Nortel	-	-	-	-	y	-	y	-	y	y	-
a05	Telstra	-	y	y	y	-	-	-	-	y	-	-
a05	NEC	y	-	-	-	-	-	y	-	y	y	-
a06	Alcatel	-	-	y	y	-	-	y	-	y	-	-
a06	JTEC	-	-	-	-	-	-	-	-	-	-	-
a07	Optus	y	y	y	y	-	-	y	y	y	y	y
a07	DEC	y	-	y	y	y	-	-	-	y	y	-
a08	Optus	y	y	y	y	-	-	y	y	y	-	-
a08	Fujitsu	-	-	y	-	y	-	y	-	y	-	-
a09	Optus	y	y	y	y	-	-	y	y	y	-	-
a09	Leightons	y	-	y	y	-	-	-	y	y	y	-
a10	Optus	y	y	y	y	-	-	y	y	y	-	-
a10	Nokia	-	-	y	-	-	-	y	-	y	y	-
a11	Optus	y	y	y	y	-	-	y	y	y	-	-
a11	Nortel	-	-	y	-	y	-	y	-	y	y	-
a12	Optus	y	y	y	y	-	-	y	y	y	-	-
a12	NEC	y	-	y	-	-	-	-	-	y	y	-
a13	Nokia	-	-	y	-	-	-	y	-	y	y	-
a13	ERG	-	-	-	-	-	-	-	-	-	-	-
a14	Vodafone	-	-	y	-	-	-	y	y	y	-	-
a14	Ericsson	y	-	y	-	y	-	y	-	y	y	-
a15	Vodafone	-	-	y	y	-	-	y	-	y	-	-
a15	Keycorp	-	-	y	y	-	-	-	-	y	y	-

Code	Description	Code	Description
ma	market access	agr	abide by gov't requ'ts
ca	access to capital	rs	risk sharing
lea	access to labour & expertise	ii	increased innovation
ta	access to technology	gmc	global market capabilities
csl	customer-supplier links	pct	pre-empt competitive threats
es	economies of scale		

Table 2: Alliance Motives and Motive Codes.

5.2 PARTNER SELECTION

Howarth, Gillin and Bailey (1995: 121-122) have identified some obvious qualities that one should look for when selecting a strategic alliance partner. These include commitment, expertise and experience, financial stability and health, organisational culture and previous experience with successful alliances. Many of these factors were identified (or implied) during the course of our interviews, but the three criteria that dominated were ***synergy*, *personal relationships*** and ***trust***.

Synergy was seen as being especially important. The chances of a successful alliance were viewed as good if the prospective partners were in essentially different core businesses and each party had something (product, service or expertise) that the other party needed. Alternatively, most interview subjects said they would be reluctant to enter into an alliance with a partner in the same core business (although, principally because of Government requirements relating to the fostering of local industry, alliances of this type were identified).

Personal relationships and trust are closely related and were mentioned by a significant proportion of interview subjects. The less-formal nature of most strategic alliances may bring major benefits, in the form of improved efficiency, more rapid response times, decreased overheads and a results focus, but requires a substantial level of trust - especially on a 1:1 basis at all levels of the alliance. Instances were reported of alliances that had started well but had deteriorated when key personnel were replaced. A downside to close relationships is that, at the technical level, professional loyalty and technology seductiveness can sometimes become dominant, leading to a lack of focus on wider business and alliance objectives.

A further partner selection criterion seen as important by some suppliers was that the alliance should offer the opportunity to enhance the ***credibility*** of their companies. As such, the size, scope of operations, technology employed, profile and visibility of prospective partners were seen as key factors. These suppliers were of the view that early success (even at a loss) could lead to future opportunities (with both the initial partner and with other companies - not necessarily in the same line of business).

5.3 ALLIANCE MOTIVES

Interview subjects were asked to identify their motives for entering into the various alliances in which they were involved and their responses are summarised in Table 2. The 11 motive types employed were derived from the literature in the field (e.g. Howarth et al., 1995; Lorange and Roos, 1993; and Cauley De La Sierra, 1995). The reader should note that a "-" in Table 2 means that the motive was not mentioned during an interview and not that the motive is certainly unimportant to the company concerned. The table will be refined and expanded during the next phase of the study.

In Table 3, motive type totals for carriers, suppliers and both are presented. This table was derived from Table 2, restricted to the 13 carrier-supplier relationships for which we have responses from both sides. Some interesting features of the data in Table 3 are: 1) *increased innovation* and *access to labour and expertise* were mentioned by most subjects, whether carrier or supplier. *Market access, abiding by Government requirements* and *global market capability* were other motives mentioned by significant numbers on both sides; 2) *access to technology, access to capital* and *risk sharing* received a significant number of mentions from carriers; 3) *customer-supplier links* received a significant number of mentions on the supplier side; and 4) overall, carriers appeared more demanding and appeared to expect more out of alliances than suppliers (total mentions of 88 versus 69).

Subjects were also asked to rate the overall success of alliances on a 1-5 scale (with 1 meaning a disaster, 3 meaning good and 5 meaning extremely successful). Results are presented in Table 4 (note that there is no direct correspondence between pairs of rows in Table 2 and columns in Table 4).

	ma	ca	lea	ta	csl	es	agr	rs	ii	gmc	pct	Total
Carriers	6	11	13	12	4	0	8	11	13	5	5	88
Suppliers	8	0	11	3	8	0	9	3	14	12	2	69
Both	14	11	24	15	12	0	17	14	26	17	7	157

Table 3: Totals by Motive and Partner Type.

Carrier	5.0	5.0	5.0	4.0	4.0	5.0	5.0	2.0	1.0	5.0	3.5	2.0	46.5
Supplier	4.0	3.5	3.5	5.0	4.0	4.0	4.0	3.0	3.5	3.0	3.5	3.5	44.5

Table 4: Level of Achievement Ratings.

Overall, the alliances investigated were viewed as quite successful from both the carrier and supplier sides. Interestingly, despite the carriers appearing to want more out of their partnerships, the overall level of achievement was seen as much the same on both sides (with means of 3.87 and 3.71 for carriers and suppliers respectively). However, as indicated in Figure 1, the view from the supplier side was very consistent (with a fairly tight distribution around the median), while carrier ratings were more spread.

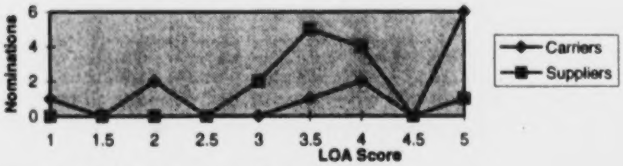

Figure 1: LOA Nominations Spread.

5.4 PROBLEMS AND COSTS

The actual or potential problems of most concern that were identified were associated with the related areas of developing relationships and learning about partners' organisational cultures. The importance of parent company and senior management involvement was seen as vital by many interview subjects; but, once an alliance has been formed, securing appropriate levels of senior management commitment and involvement was considered to be relatively easy compared with breaking down barriers at middle and lower organisational levels. Furthermore, effort expended in breaking down these barriers (including the establishment of appropriate cooperative arrangements and the mutual development of an appreciation of partners' cultures) translated into substantial real costs. For example, Optus and its partners have poured considerable money, time, effort and other resources into a series of workshops aimed (in part) at realising these objectives.

The Optus workshop programme was intense prior to, and at the beginning of, the carrier's operations and is ongoing in some of the relationships. This is understandable and, indeed, perhaps necessary given the impact that time can have on an alliance. This is especially the case where one or both partners is growing rapidly (or changing markedly in other ways), since it appears that issues related to organisational power are almost certain to surface in these circumstances. For example, one interview subject commented that, following growth, its partner's culture had changed. In particular, empire building had occurred, considerable effort had been expended on influence strategies, hidden agendas were rife, communication channels had changed and, most importantly, the partnership emphasis had changed from "getting the job done" to "cost control". These views were echoed by other interview subjects.

All the above represent classic symptoms of power plays (Pfeffer, 1992) but they can also be symptoms of other, more fundamental problems. Specifically, instances were reported to us of communication flow problems due to inadequate parent company involvement; and a number of subjects nominated poor project management as the underlying cause of a great many problems with strategic alliances.

Finally, one other issue that was of some concern was that entering into an alliance limited both partners' ability to go back to the market and take full advantage of price reductions. The general view, however, was that the positives (security, reduced integration effort, enhanced credibility etc.) outweighed these potential costs.

6. THE ANSWER TO INDUSTRY ILLS?

As indicated in the previous section, our early results present a generally favourable picture of current Australian telecommunications sector strategic alliances. A number of these alliances have now been in place for a number of years and alliance participants are generally pleased with progress to date. The one alliance that has been dissolved has been replaced by another - of a different form, but with the same parties and basic objectives maintained. In addition, it seems clear that the Keating Government played a positive role in the fostering of these alliances, though the Howard Government may choose a different path.

However, despite this perceived success, sufficient concerns have been expressed to us to indicate that alliances are far from the universal magic bullet or panacea that many advocates have envisaged and argued for as the solution to industry ills. Moreover, other research would suggest there is good reason for caution. For example, overseas studies by McKinsey & Co, Coopers and Lybrand, among others, show that 7 out of 10 joint ventures do not meet expectations or disband; and international alliances are even more prone to failure (Stafford, 1994). Bain and Co. found that only 2% of all alliance negotiations actually produced lasting performance improvements for those involved. Furthermore, even if they succeeded, strategic alliances were expensive exercises (Rigby and Buchanan, 1994).

In Australia, Limerick and Cunnington (1993), while emphasising the advantages of external networks, particularly for competitive advantage, have highlighted the real problems inherent in strategic networks - those of goal ambiguity and network boundaries; problems of sovereignty; asymmetry; the creation of potential competitors; the tendency to focus on the short-term rather than the long-term relationship; issues of communication and control; and the real concern with differences in cultures.

Teece (1986) had already earlier warned of the problems in the euphoria over "strategic partnering", suggesting that there were few balanced presentations of the real costs and risks, especially to the innovator involved in the partnership. He emphasised real dangers in a partner's performance falling short of an innovator's perception of what the contract requires and the added danger that a partner might imitate the innovator's technology and try to compete with the innovator. Certainly the development and management of the human dimensions of relationships involved appears critical, is often overlooked, and echoes early findings of our own study.

7. CONCLUSION

While there are many studies on cooperative relationships in a wide variety of industry sectors, one factor that emerges is that the basis for interfirm alliances and the nature of ongoing relationships is critical. There has been relatively little work done on strategic alliances in high tech industries until quite recently. Those few studies done on the telecommunications industries have tended to focus generally on equipment aspects or, indeed, on the rationale for collaborative arrangements and the variety of contractual arrangements (often from an economics perspective with an emphasis on quantitative methodology). We have been unable to locate many that track the very nature of the collaborative arrangements using other approaches, particularly longitudinally. A recent exception, here, is the small case study by Low (1995) which explores an equipment dealer's approaches to changes in positioning strategy in the Australian telecommunications industry networks sector.

Our study aims to remedy such omission, at least partially, by using a multiple method, longitudinal approach that may tell a different story to the few so far in the field. There is an emphasis on the interorganisation communication or social context of alliances that emerge only over time and which can only be understood by a longitudinal examination of the organisations' relationships (Gulati, 1995). The role of government in such alliances is also an important consideration.

Insofar as the results of this study are concerned, clearly there needs to be continued consultation between industry and government. Certainly many would argue that government involvement, post 1997, in freeing up the market is critical, building on the benefits of the present government programs and policies; urging Australians to continue their early adoption of new telecommunications technologies and services; and continuing with competition and benchmarking.

The costs and effects of continued government fostering of strategic commercial relationships between suppliers and carriers is, as yet, unclear. As a result of several case studies of international collaborative ventures in American manufacturing, Mowery (1988), however, argues that it is inadvisable and unfeasible for public policy to regulate international collaborations. Yet he does stress that such collaborations in the telecommunications equipment industry will be a permanent characteristic of global competition into the foreseeable future. Our study findings concur with such a view, endorsing the broad brush approach of the Australian Government in providing the environment but leaving the micro-level detail to the industry players.

Finally, we should also note that, while assisting innovation and industry performance in one sense, as James and Weidenbaum (1993: 101) suggest, "... the resulting web of interrelationships between firms within specific industries can be viewed as an impediment to innovation and long-term economic efficiency." Freezing the structure of our or others' telecommunications industries could be the death knell of innovation. Certainly our study so far demonstrates

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that both government and industry players understand the potential for dysfunctional management inherent in attempting to provide rigid recipes for sustained strategic success in the telecommunications arena.

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Structuring a Financeable Telecommunications Installation Project

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1. ABSTRACT

In order to successfully achieve the participation of project lenders in an international telecommunications installation venture, equity sponsors must structure the project in a way that conforms to market expectations. This paper outlines certain key building blocks that sponsors would do well to keep in mind in structuring a financeable telecommunications project, and also highlights the basic expectations of lenders, equipment vendors, governments and other participants in these projects.

While there are many opportunities in the telecommunications industry today, some of the most important ones are presented by the opening to the private sector of network installation and operation heretofore available only to the public sector. Through partial privatizations, governments have ceded some significant benefits and responsibilities to private industry for the installation of fixed line and cellular networks. These projects are often financed on a limited recourse basis, with funding provided by a variety of sources. The successful financing of these telecom installation projects depends upon a complex series of factors, some of the more significant of which are discussed below.

2. PROJECT PARTICIPANTS

A preliminary hurdle that must be overcome for a project to be financeable is the divergent background and experience of the various participants who each come forward with different expectations. Project lenders typically expect at least some of the sponsor participants to be sophisticated and experienced players in the telecommunications market. A developer's success in securing financing and implementing the system — and often (but not always) its chances for winning a concession or license — will largely depend on the experience and aptitude of its management team.

For example, the international investors and equipment suppliers who will be supplying equity and structuring and negotiating key project documents are likely to have substantial experience negotiating with commercial banks in developed financial markets such as the United States and the United Kingdom, and have become accustomed to project-style allocation of risks and rewards among sponsors, equity providers, lenders and other project participants.

On the other hand, sometimes local sponsors and domestic banks — especially in the emerging markets where many of the privatizations are occurring — may not be as familiar with international practices in the field and may seek alternative approaches. The expectations and requirements of the parties will be very different depending on the jurisdiction in which the project is located.

However, even if there is no question but that local enterprises must be included in the project because their participation is required by law or the terms of a concession tender, their participation can, in any event, also serve to enhance the project's financeability. During the course of any project, participants are likely to suffer a series of ups and downs and uncertainties as a result of shifting political winds or struggles among government agencies. One way of understanding and dealing with the political process is to seek broad-based local participation in the project, either through local equity ownership, inclusion of host country banks in the lending syndicate or cultivation of local supplier relationships in order to assure reliable host country support in the event of an unstable situation.

Lenders also consider it important to have a sophisticated, experienced operator of the project who is committed to staying with the project, ideally throughout its implementation, and at least through the construction or "roll-out" phase and initial operations (at which time the local sponsor may have sufficient experience to operate by itself).

In addition, the presence of certain types of lenders in the transaction can itself enhance the project's financeability. Export credit agencies (ECAs) can provide political risk insurance and typically are especially eager to finance and participate in "high visibility" projects involving sophisticated technology as is invariably required in telecommunications projects. In light of this situation, ECAs have gained favor as a source of financing. Some of the most valuable support from ECAs has been attributed to their ability to mobilize other sources of capital, as the very presence of ECAs serves to mitigate political risks. Though ECAs have a history of providing support to telecommunications projects through established methods of loans, equity investments, and political risk insurance, they are are generally willing (albeit perhaps more cautiously than their commercial bank counterparts) to create new techniques to keep pace with their expanding roles.

In addition to established ECAs, multilaterals such as the Inter-American Development Bank and the Asian Development Bank are actively pursuing numerous telecom projects. While financing and technical assistance are a primary function of multilaterals in telecommunications projects, their scope is much broader. Given the instability and rapid change in some emerging markets, multilateral organizations are becoming increasingly involved in solidifying regulatory structures which might be hindering project development. In China, for instance, the weak regulatory framework and the very restricted opportunities for foreign parties to be involved in the telecom sector have motivated telecommunications operators to limit their focus to turn-key projects for state-owned agencies. Due to the telecommunications industry's historic reliance on government regulation, multilateral lenders have begun expanding their role in these projects from advocating for government improvement, to actively promoting systematic changes. An example of this role is seen in Bangladesh where the World Bank is aiding the government in formulating a telecommunications policy for an enhanced private sector.

This focus on regulatory reform, however, has not steered ECAs and multilaterals away from participating in projects with significant political risk. The willingness of ECAs to participate in such projects provides significant encouragement to commercial banks and other institutional lenders interested in gaining presence in expanding markets of newly industrialized countries.

3. COMMITMENT OF PROJECT PARTICIPANTS

Lenders generally look for firm commitments to the project from the major participants. Equity must be committed, fixed and (to the extent required) in place, before lenders will disburse funds. Moreover, lenders generally require agreement of the sponsors that they will remain committed to the project throughout its life, notwithstanding political events or other factors.

A recent project in the Phillippines, for example, was structured in such a way that the foreign telecom operator had the right to abandon the project on two months' notice. However, before financing could be obtained, contracts had to be rewritten to solidify the commitment of the sponsors.

Likewise, the operator, technical assistants and equipment suppliers must each be contractually committed to the project so that lenders can be assured that the project construction and operation will proceed smoothly, without the significant disruptions that could be associated with replacement of major participants.

Any operations contract, while not common in telecom projects, would be of particular concern to lenders. Lenders will want to be assured of sufficient remedies in the event of acts or omissions of the operator that result in third-party liability. Operators will often argue that given their limited potential return under an operations agreement, exposure to potential liability should be capped.

Lenders also look to the contractors and equipment suppliers to demonstrate significant commitment to the project, principally through the inclusion of liquidated damage provisions tied to a guaranteed completion schedule and network performance.

Delay damages are often structured to replace revenue that is foregone as a result of a missed target date for completion, and that is needed to ensure the project company's ability to make debt service payments. The payment of performance-related damages may be secured by retaining a certain percentage of the contractor's monthly progress payment or by the posting of letters of credit in satisfaction of the contractor's retainage obligations.

In addition, lenders require that major project participants agree not to delegate their obligations under the operative documents and further require that such obligations not be easily terminated.

Because many telecom projects, with notable exceptions such as small cellular installation projects, do not make use of a single "turn-key" supplier, significant issues of construction risk, as well as sheer negotiating complexity, can arise from the presence of multiple equipment suppliers. Large-scale fixed-line projects are often divided into geographic sections and can involve 20 or more vendors for switches, microwave transmission equipment, copper and fiber optic cables, wireless local loop equipment and so on.

In addition, the multiplicity of roles often assumed by telecom project participants adds to the complexity and requires careful coordination. The basic investment arrangements, generally involving the equity or sponsor side of the transaction, should be considered in conjunction with the other roles that may be played by a sponsor, whether as equipment supplier, operator, or provider of services or technical assistance. Sometimes, due to the technical nature of the matter or the structure of the business organization, these various roles and duties are negotiated by different teams from the same party, leading predictably to a lack of coordination and a coherent approach to issues.

For example, equipment suppliers are increasingly being asked not only to furnish debt financing in some form but also to take on an equity role if they wish to make the sale. And telecom operators are serving as equity participants, technical assistance providers and perhaps traffic carriers as well.

Consequently — as an example of the need to consider these issues together — the parties need to consider early on whether premature termination of the technical assistance agreement would allow the operator to pull out its equity stake. In some cases, an equipment supplier will take a chance on an equity position in a consortium bidding for a telecom franchise, in the hope that the consortium, having won the bid, will purchase the supplier's equipment. If it later turns out that the successful consortium, for whatever reason, does not want to buy from that supplier, it will understandably wish to have the right to back out of the equity arrangements. All parties must recognize and be prepared to deal with these commercial realities.

4. GOVERNMENT PARTICIPATION

Project financing of telecommunications projects provides many countries with a credible alternative to the traditional method of central government financing and operation of telecom assets. While governments are often reluctant to relinquish totally their sovereign control over valuable assets, they recognize the need to attract foreign investment. The resulting balancing of goals leads to a package of rights or concessions granted by the government, often accompanied by additional government support.

Sponsors eager to invest in an international telecom opportunity seek to maximize this package of benefits bestowed by the government. However, they should take care to assure that the government concessions and support are properly structured, or there may be a risk that lenders will require the agreed arrangements to be reopened.

For example, in a recent project in Thailand, a project company with an existing fixed-line concession was able to obtain an award of an additional PCS license; however the license presented certain financing difficulties that had to be addressed. These difficulties arose principally from the fact that the parties did not clearly indicate that a potential default under the new PCS license would not jeopardize the validity of the existing concession.

4.1 FRANCHISE/LICENSE TERMS

The terms of the government franchise or license must be in a form that is acceptable to lenders. Primary among lenders' considerations in this regard is that the license be of sufficient duration, be clear in scope and contain adequate limits on termination rights. To ensure cushion between the final loan payment and the term of the revenue source, lenders typically structure the term of the debt so that the final payment under the loan agreement occurs substantially prior to termination of the license.

Central to the lender's evaluation of the financeability of a telecom project is its evaluation of the credit risk of the entity or entities that are paying revenues to the project company under the license. Where the project is structured so that the subscribers are billed directly by and make subscription and usage payments to the project company, the analysis is essentially one of market demand and capacity. Where, however, the public telephone enterprise remains responsible for dealing with the ultimate subscribers, revenues to the project company are in the form of periodic lump sum payments from that enterprise, pursuant to the terms of the concession or comparable agreement. Thus, the project cash flow, and the project's resulting financeability, will be directly dependent upon the ability of the public sector entity to perform its obligations under the concession agreement.

4.2 CONSENTS

Governments may be asked to grant specific consents in favor of the financing parties to grants of liens on revenues payable by the government to the project company. Lenders also typically require that the government consent to the assignment by the project company to the lenders of the company's contractual rights against the government, including payment rights. Generally, lenders require payments to be made directly to the security agent.

As a matter of principle, governments are typically stingy about the scope of consents they will give. In some cases, governments may well recognize that the comfort afforded the financing parties – and thus the facilitation of the overall project – by reason of a more complete consent would not in a practical sense come at the diminution of the sovereign's rights.

The government franchisor must also grant the security agent the right, without any further approvals required, to step into the shoes of the project company if there is a default under the loan agreement. Structuring of this right generally requires separate consent agreements whereby each party to a principal project contract, including governmental parties, consents to the collateral assignment of such contract in order to ensure that the assigned contract will be enforceable and transferable by the security agent if it enforces the lenders' security rights. While the consents are not particularly complex legal documents, they are viewed as essential credit documents because of the lender's need to be able to operate the project following foreclosure.

4.3 GOVERNMENT SUPPORT

In order to enhance the financeability of telecom projects, governments are often asked to provide additional support.

This support, for example, can take the form of a commitment by the government that it will assure a supply of necessary hard currency. Since developing countries may not have convertible currencies, access to foreign exchange is necessary to satisfy foreign lenders that debt service payments can be converted into their own currency. Arrangements should be made for access to hard currency through the host country's central bank, as authorized by regulations or contractual arrangements between the host country government and the project.

Government support may also take the form of agreements to facilitate the admittance of, and granting of work permits to, qualified expatriate personnel necessary to construct and operate the project. If a host country government is eager that its own citizens have access to skilled positions within the project, agreements might be negotiated which balance the project's requirement for experienced, skilled personnel with the need to create opportunities on a gradual basis for host country nationals.

Since telecom project developers and operators often need to import components of the network system, the host country government might also assure that such items are not subject to import restrictions, and may even wish to consider the waiver of any import tariffs that might be incurred as an added incentive to sponsors and to lenders.

In some instances, more direct forms of government support have been used to mitigate revenue risk. In some recent telecom projects in Colombia, for example, the government has agreed to make payments to the project company to cover certain shortfalls in project revenues.

Other forms of government support include agreements of the government that it will refrain from nationalizing or expropriating the assets of the project company; that it will not compete with the project company or grant competing licenses; that it will purchase a specified quantity of services from the project company at a specified price; and that it will supply a specified quantity of materials or existing infrastructure needed in order to exploit the telecom license efficiently.

Lenders also typically seek assurances from the host government regarding changes in tax laws, increases in tariffs, non-interference with project agreements, non-revocation of project licenses, and the like.

If the government fails to perform its various undertakings and commitments, there must be adequate remedies available to the project company (and, by assignment, the lenders). Typically, such remedies would include the government's consent to suit on its representations, indemnities and contractual commitments. This consent may involve a formal waiver of sovereign immunity or agreement to submit to binding arbitration in a neutral forum, steps which some governments have been willing to take.

Other remedies take the form of agreements by the government to purchase the project assets upon certain defaults at a specified price; lenders typically require the purchase price to be set at an amount at least sufficient to enable any outstanding indebtedness to be paid off and, in some cases, sufficient to enable the sponsors to recoup their equity contributions.

5. STRUCTURAL FLUIDITY

Unlike traditional project finance, which generally involves the financing of a single facility, telecom projects tend to combine new construction and installation with existing infrastructure, and to expand to take advantage of rapidly developing technology. In short, the uniquely evolving and expanding nature of telecommunications projects presents its own special structural challenges. Sponsors are typically eager to expand the scope the telecommunications venture, either through an expansion of the services offered under the existing license or through the bidding for additional licenses.

Expansions under existing telecom licenses can, for example, involve the addition of services such as ISDN lines, call waiting, cable television or video telephones. In contrast to expansions of other types of infrastructure projects (such as power plants), this type of telecom expansion does not always require wholesale alterations to most components of the physical project, and instead can often be limited to upgrades of discrete project components such as switching equipment.

The second type of expansion often seen in telecom projects involves bidding for additional licenses or other operating authority. For example, a project holding only a cellular license might consider itself well-positioned to bid for a land line license.

From the perspective of project lenders, this inherent fluidity in telecom ventures presents certain additional risks but also carries certain advantages.

Risk and monitoring costs may be increased to the extent that there is often no fixed point at which a telecom project reaches "final acceptance" from the viewpoint of lenders. In contrast to power projects, it can be difficult in many telecom projects to set up objective criteria for project completion that can be monitored effectively by a technical representative of the lenders. Equipment acceptance as between the vendor and the project owner typically occurs on a rolling basis with respect to each separately switched group of lines, and may be different from the time at which such lines are connected to subscribers or to the public switched network.

However nettlesome these acceptance difficulties may be, an offsetting advantage of telecom projects from a lender's perspective is that revenues begin to be collected as soon as the first lines are connected. Losses due to *force majeure* and other factors are also limited to only the affected lines. Such early cash flow and potential segregation of losses create opportunities for structuring the project in ways that increase lenders' comfort with the relatively unpredictable scope of the total venture.

6. INTERCREDITOR ARRANGEMENTS

Because of the large capital amounts required for major telecom infrastructure projects, no single creditor is likely to be able to supply the entire project debt. As a result, a variety of lenders jointly participate in most telecom projects.

Often, project debt is provided by a group of lenders comprised of such various categories as commercial banks, capital markets debt, export credit agencies and multilateral agencies. Coordination among such diverse groups of lenders is a project in and of itself. Commercial banks are the players on the lenders' side who have the experience and the resources to take on this job.

Most of the complex intercreditor issues in the financing of telecom projects concern security sharing. Arguments about ceding control of rights of enforcement between different tranches of lenders, or between the lenders and other project participants, are often heavily negotiated. In addition, debate can often rage over the proceeds of enforcement and this can be complicated even further if not all lenders are to share equally in all of the security.

Project sponsors must also be careful to ensure that the project's financial plan takes into account the legitimate needs of each creditor group.

7. CONCLUSION

As a means of bringing rapid and cost-efficient telephone services, often with the latest technology, private-sector telecom installation projects can accord important and attractive benefits to sponsoring governments, PTO's, local and international investors, commercial and public-sector lending institutions and other industry participants. But the intrinsic nature of telecom projects, with their high capital costs, specialized construction programs and constant technological and service expansion, presents complexities and problems not seen in customary project financing. As with most commercial undertakings, these complexities and problems are more effectively ameliorated at the initial structuring stage, when the most flexibility is available, rather than at the later negotiation and documentation phases.

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Taiwan's Strategies for IT-led Development and NII: A Longitudinal Study

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1. Abstract

Since the early 1980s the Taiwanese government has implemented the "Information Industry Development Plan" (1980-1989, 1990-2000), which is aimed at a two-fold mission--encouraging production of the IT sector and promoting IT use in the economy. Looking at the issue of IT-led development, the following questions arise: Are Taiwan's IT policies effective in leading to enhancing national use in IT? Does encouraging IT use pay off for the economy? This paper presents a *national IT-capabilities-enhancing* approach empirically examining the interconnections among national technological capabilities (reflected in IT policies), national investment in IT, and economic growth over a period of 16 years.

2. Introduction

Information technology (IT), as used in this paper, includes computer and communications hardware, as well as software and associated services. The contribution of IT to an economy is predominantly through its applications and adoptions. The adoption and spread of innovations produces most of the economic benefits of a new technology.

The diffusion of IT throughout all industries seems far more important than the production of computer industries *per se*, as Flamm (1987) noted in his study on America's computer policies. The focus of government policy on IT development in OECD countries has recently begun to change increasingly towards IT diffusion (i.e. the use side) as opposed to generation (i.e. the production side) (Hanna, Guy & Arnold, 1995). This shows that many OECD governments have begun to formulate IT-related policies justifying an interventionist approach to promote IT usage. As a number of studies have summarized, both manufacturing and service industries in OECD countries and East-Asian NIEs are increasing a broad range of IT use as a key strategic tool in sustaining competitive strength in the global market (see e.g. Jussawalla, 1995).

This study looks at NIEs as *IT users* and the impact of government policies on them to enhance national technological capabilities conducive to IT investment and adoption. Pervasive investment in information technology in the industry sector may lead to economic growth at the national level. By *empirically* examining the relationships among three variables--national technological capabilities (reflected in IT policies), IT use and economic growth--this study explores enhancing Taiwan's national technological capabilities that have been implemented in IT policies, evaluates the impact of increasing IT use, and draws conclusions with particular significance of IT-led development in East-Asian NIEs. The study described later investigates the longitudinal data of factors of national technological capabilities, investment in IT and economic growth over a 16-year period from 1980 to 1995.

2.1 IT Use and Policy Mechanism in East-Asian NIEs

IT is the most pervasive generic technology today and has been increasingly recognized as one of the major agents of economic growth and corporate competitiveness. The burgeoning worldwide *information economy* driven by the convergence of computing and telecommunications has provided new growth opportunities for East-Asian newly industrialized economies (NIEs), as both users and suppliers.

As users, some NIEs such as Singapore, South Korea and Taiwan have formulated desirable and feasible initiatives to facilitate the use of new information technologies within existing industries in order to increase economic growth and sustain a competitive edge in the global community. It is widely recognized that governments clearly can shape the environment in a way which either accelerates or retards the pace of IT use. Governments in East-Asian NIEs have played an important role in building scientific and technical infrastructures which are conducive to the efficiency of adopting IT in government and industry.

The question of what factors give rise to national technological innovation and prompt economic growth has fueled heated debates in recent years. As noted in recent literature on development economics and innovation, an important feature of the success of East-Asian NIEs has been the effectiveness of the state as an agent of industrial transformation and economic growth. In a recent study focused on Taiwan, Wade (1990) elaborates the importance of institutions and proposes the "government market" theory. He argues that the "state corporatist" power structure has facilitated government's efforts to pursue a "leadership" role in *strategic industries* rather than simply a "fellowship" role.

2.2 IT Use and Economic Returns

The global economy is moving in the direction of a so-called information economy, or as Nicholas Negroponte (1995), the director of MIT Media Lab describes in his recent book *Being Digital*--"the change from atoms to bits is irrevocable and unstoppable." Information (bits) is becoming a strategic resource in the information society; information technology is recognized as a strategic technology for today's business practices in the restructuring of an economy. Telecommunications is the backbone, the highway or corridor, that carries information services.

Theoretical links between information technology and economic growth have often been made in the literature. Yet, until recently, empirical research on the relationship between IT use and economic returns has produced little confirmation. Recent empirical studies note that investment in IT may have led to or anticipated dynamic economic growth or productivity in the U.S. (National Research Council, 1994) as well as in East-Asian NIEs (Kraemer & Dedrick, 1994).

3. IT-led Development in Taiwan

There is widespread recognition among policymakers that IT is the *key* technology for enhancing economic development and strengthening competitiveness. Sufficient IT capability and the efficient deployment of IT policy may soon be indispensable for sustaining global competitiveness in an increasingly integrated, information-intensive, global economy. The national IT plans adopted in most Asian NIEs share a common notion--*IT-led development* refers to national development that is led by various types of IT, which includes both the IT use side and IT production side, to transform less developed countries to the information society. Stemming primarily from a strategy of *IT-led development*, a great number of Asian countries have recently introduced initiatives in launching national information infrastructure (NII), aimed at leapfrogging toward *the information society* through increasing IT diffusion and encouraging IT production (see Table 1).

The strategies of national IT plans in most Asian countries share the following key foci, although on a different development scale:

- Build an enhanced information infrastructure--upgrade telecommunications networks, increase the number of IT professionals through education and training.
- Encourage IT use --accelerate computerization in government agencies, private sector and the public.
- Promote domestic IT production--develop both hardware and software industries.

As noted, the national plans aimed at promoting IT use are often embedded in a broader "technology policy" which places more emphasis on IT production than on IT use.

3.1 Evolution of Telecommunications

Taiwan is one of those countries where uniformly priced universal service as a first priority was the foundation of local network development strategy. In 1981, when the goals of "a telephone in every village" and automatic subscriber direct dialing systems had been achieved, basic universal access was considered successfully achieved. In order to meet the market demands of MNCs and provide state-of -the-art data communication services by the year 2000, the Chinese Telecom now is accelerating its islandwide plan for fiber-based digitization which is recognized as the trunk for the National Information Infrastructure

The development of the telecommunications infrastructure in Taiwan has demonstrated great momentum over the past four decades. However, Taiwan needs to put more effort into improving tele-accessibility, which generally is an indicator of the basic services and benefits the public can accrue from telecommunications. Chinese Telecom projected that by the year 2000 Taiwan will be able to increase the main lines per 100 inhabitants to 61.55, compared to

Table 1 Initiatives of National Information Infrastructure in Some Selected Asian Countries

Country	Launching Time	National Initiatives	Steering Agency
Singapore	March 1992	IT 2000--Intelligent Island	National Computer Board
Taiwan R.O.C.	August 1994	NII 2005	NII Steering Committee
South Korea	1994	NII 2003	Ministry of Information and Communication
Japan	May 1994	Establishment of High-performance info-communications Infrastructure Program	Telecommunications Council of the Ministry of Posts and Telecommunications (MPT)
Thailand	1995, IT year	IT 2000	National IT Committee
Philippines	1994	National Information Technology Plan (NITP) 2000--Smart Philippines	National IT Council
Malaysia	Feb. 1991	NIT, part of Malaysia Vision 2020	Ministry of Technology
Vietnam	Aug. 1994	IT 2000	National Program on IT Steering Committee
China	1992, 1995	NII 2020--a series of Golden Projects	MPT, Ministry of Electronic Industries, etc.

the current levels of 59.63 in Japan, 55.66 in Singapore, 67.62 in Hong Kong, and 65.92 in the USA. Taiwan authorities recently decided to further liberalize its telecommunications sector. The legislature passed three bills altogether in January 1996 aimed at further opening the telecommunications market to private investment. The three bills are the revised Telecommunications Act, the revised Statute of Directorate General of Telecommunications and the Draft Statute of Chinese Telecommunications Company (CTC). It is widely recognized by the private sector that passing the revised Telecommunications Act is a milestone in liberalizing the telecommunications market. The government agency DGT was reorganized into Chinese Telecom on the first of July 1996. Since then the power-reduced DGT played its role as an industry regulator overseeing fair competition between Chinese Telecom and new entrants. The DGT also announced that cellular telephone, paging, trunked radio and very small aperture terminal (VSAT) satellite services will be opened to competition and foreign investment as the initial phase of liberalizing telecommunications services by yearend 1996. The large state-run corporation, Chinese Telecom with its 36,000 employees, expects to be further privatized over a five-year period. In addition, the telecommunications environment is being liberalized. Taiwan's cable TV market is one of the most-developed in the Asian region. An ambitious plan integrating cable TV systems with the telecommunications network is now undertaking the first step to build a robust NII.

3.2 IT Use

In 1980, Taiwan's government designated the information industry as a *strategic industry* in order to lead industrial restructuring and to hasten industrial upgrading. With the realization of the importance of IT, the Institute for Information Industry (III) was established as the coordination agency in 1980 under the direction of the Executive Yuan (the Cabinet). As explicitly announced in the "Information Industry Development Plan"(1980-1989) (Phase II 1990-2000) which was initiated by Executive Yuan, there are two-fold missions for III and other government agencies to coordinate and collaborate together:

- The primary purpose of IT development is to develop the IT industry as one of the major export sectors in the economy.
- Secondly, it is expected that applying IT in government agencies and all other industry sectors would enhance government efficiency, and improve labor productivity and economic development.

In the 1980s, IT use did not receive as much government effort as its industrial production, and the rate of IT use in small and medium enterprises (SMEs) was far below expected levels. This has been changing since the early 1990s. The government has realized that promotion of IT use and the development of the domestic software industry are closely interlinked. Increasing domestic IT use will provide a market for the software industry and developing locally-oriented Chinese-language software will encourage IT use. Accordingly, the government has offered more subsidies and tax incentives to promote IT use in both manufacturing and service sectors.

As reflected in the IT policies, the way of enhancing national technological capabilities primarily involves leveraging human resources through education and training, speeding up R& D expenditures, and upgrading telecommunications infrastructure by increasing investments and further deregulation.

4. An IT-Capabilities-Enhancing Approach

Given information technology as a frontier example, this study reflects the perspective that effective government policies on enhancing national technological capabilities may contribute to facilitating adoption in IT at both the firm and macroeconomic levels. Innovation and improvements from IT use undertaken by the industry sector may enable economic growth as a whole.

Ergas (1987) brings in upgrading ***national technological capabilities*** as a critical factor when explaining innovation success. Those elements embedded within national technological capabilities can provide a useful indication for technology diffusion. Three elements emerging from Ergas' comparative analysis are-- investment in human resources, policy decentralization, and providing incentives for R&D. A central feature of innovation performance is a country's technological infrastructure--its system of education and training, its public and private research laboratories, and its network of scientific and technological associations. Thus, technology policies cannot be assessed independently from their institutional context.

Stemming from a synthesis of previous studies (e.g. Nelson, 1993), *national technological capabilities* in this paper are presented as the following:

- Human Resources --Education and Training
- Research and Development (R&D)
- Telecommunications infrastructure

The research model is presented in Figure 1.

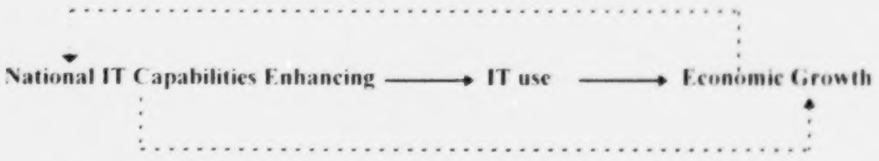

Figure 1 Research Model

5. Research Methodology

The data on national technological capabilities, IT use, and economic growth were obtained from the following government agencies: 1) Directorate General of Telecommunications, 2) Directorate General of Budget, Accounting and Statistics of Executive Yuan, 3) Institute for Information Industry, 4) Ministry of Education, 5) National Science Council 6)1995 Taiwan Statistical Data Book and 7)1995 Statistical Yearbook of R.O.C. Some of the data were further calculated to accommodate the needs of the study.

5.1 Definition of Variables

1. Factors of National Technological Capabilities

- Human resources--education and training

(a). tertiary education attainment as % of total population

(b). enrollment of college/university level students in science & technology fields per 1,000 population

Lall (1990) considers the enrollment of university level students in science and engineering subjects as an important measurement of the 'potential stock' of scientists and engineers. The percentage of population attending overall tertiary level education has often been used as an indicator of education level.

- R & D--- R & D expenditure as % of GDP

The most common measure of relative R&D efforts is R&D spending as a percentage of GDP.

- Telecommunications Infrastructure

(a). (basic) main telephone lines per 100 population

(b). (enhanced) services sales as % of GDP (measured based on DGT's annual revenue)

The level of basic telecommunication infrastructure has been frequently measured by the number of main telephone lines per 100 population. of the dependent variable GDP or GNP. The enhanced telecommunications services in this study are measured by sales as percentage of GDP. The annual national telecommunications service sales (1980-1995) are primarily measured based on DGT's annual revenues, since DGT had been the monopolistic national telco until its reorganization was done by July 1996.

2. IT Use-- Average annual IT spending per organization

In this study, the indicator of IT use is defined as the total annual investment in computer hardware, software, services and telecommunications equipment. The average IT spending of organizations nationwide is measured according to the data surveyed annually by the Directorate General of Budget, Accounting, and Statistics.

3. Economic Growth --GNP per capita

GNP or GDP per capita has been always a strong explanatory factor relative to IT investment or telecommunications investment. Kraemer & Dedrick (1994) found that GDP per capita are strongly correlated with IT investment, human resources, telecommunications, wages, and R&D capacity. This suggests that level of economic development may be the key factor in IT investment, or investment in telecommunications infrastructure will contribute to economic growth.

5.2 Research Design

All macroeconomic data are measured annually over a 16-year period from 1980 to 1995, coupled with three time-lagged models--at a one-year lag interval, at a two-year lag interval and at a three-year lag interval--to reap the progressive benefits of IT investment on economic growth. The costs of IT decline sharply as the processing capacity per unit of cost for microprocessors doubles every 18 months, according to Moore's Law. Previous studies show that a three-year period seems to be a meaningful length of time.

The models are thus composed of two separated time periods: Time t for IT use, and Time t+1 or t+2 or t+3 for economic growth. For example, the independent variable, IT expenditure ratio in 1990, is grouped with economic growth in 1993 in the three-year lag model. The time-lag method attempts to show an effect in which the investment in IT during previous years may contribute to (or enhance) economic growth over a period of time. The rationale for using time-lagged analysis is that the impacts of investment in IT infrastructure usually are not fully felt immediately. Studies focused on investment in telecommunications suggest that it takes a long time to build up telecommunications infrastructure and to capitalize on its returns in order to achieve an accumulated payoff (e.g. Wang, 1996).

6. Discussion

6.1 National Technological Capabilities and IT Use

The following observations can be made from Table 2:

First, all factors including human resources, R&D, and telecommunications achieved significant correlations with IT expenditure. This strongly suggests that enhancing the level of national technological capabilities through implementing IT policies should lead to a higher level of national IT use (or vice versa). Among those factors, S&T human resources ($r=.90$, $p<.000$) and basic telecommunications infrastructure (r=.88, p<.000) present stronger positive relationships with IT expenditure.

Second, the simple linear regression further suggests that education, S&T human resources, R&D, and telecommunications infrastructure are significant predictors of IT expenditure.

Table 2 Correlation and Regression Analyses of IT Use on National Technological Capabilities, 1980-1995

Independent Variable	r	R^2	F
Education	.78	.60	21.74***
S&T human resources	.90	.81	59.22***
R&D	.87	.76	43.18***
Basic telecom	.88	.78	50.26***
Enhanced telecom	.86	.73	38.13***

*** p< .000

- **Human Resources**

Table 2 shows that 60% of the variance in national IT expenditure can be explained by the factor of education (R^2 =.60, F=21.74, p<.000); and that 81% of the variance in national IT expenditure can be explained by S&T human resources (R^2 =.81, F=59.22, p<.000). This result supports the findings of Kraemer and Dedrick (1994) and Lall (1990) that a positive relationship exists between enhanced human resources and an increase in national IT expenditure.

- **R&D**

R&D is recurrently viewed as another important factor influencing national technological capabilities. The table shows that 76% variance of national IT expenditure can be explained by the factor of R&D (R^2 =.76, F=43.18, p<.000). This result suggests that increasing R&D spending may encourage national IT use.

- **Telecommunications Infrastructure**

The table shows that 78% of the variance in national IT expenditure can be explained by the factor of main telephone lines (R^2 =.78, F=50.26, p<.000); and that 73% variance in national IT expenditure can be explained by the factor of enhanced telecom services (R^2 =.73, F=38.13, p<.000). Telecommunications networks have become a key infrastructure component for IT-led development. These findings support the premise that heavy investment in telecommunications is central to the effective use of IT for most NIEs and developing countries.

- **Multiple Regression**

Multiple regression analysis provides a comparative perspective and enables us to estimate how much each factor in national technological capabilities contributes to national IT use (see Table 3). The stepwise selection regression of the current year model presents a positive relationship as follows:

$$Y=-1582.78 + 1154.2X1$$

where Y=IT expenditure, X1=S&T human resources. The one-year lag regression model also provides a positive relationship between S&T human resources and IT use.

$$Y=-1828.06 + 1232.55\ X1$$

where Y=IT expenditure, X1=S&T human resources. The results suggest that the factors of R&D and telecommunication infrastructure would not influence the level of national IT use in the short term as much as S&T human resources.

The two-year lag regression model presents a positive relationship between R&D and IT use as follows:

$$Y=1947.81 + 10482.88\ X1$$

where Y= IT expenditure, X1= R&D. The three-year lag regression model also shows a positive relationship between R&D and IT use as follows:

$$Y=3509.33+10013.79\,X1$$

where Y=IT expenditure, X1= R&D. The results suggest an interesting tendency--R&D among other factors is becoming a more influential predictor of increasing national IT expenditure over a longer period of time.

Table 3 Multiple Regression of IT Use on Factors of National Technological Capabilities, 1980-1995

Independent Variable	B	Beta	T
Current year model			
S&T human resources	1154.02	.90	7.70***
R^2=.81, F=59.22***			
One-year lag model			
S&T human resources	1232.55	.89	6.97***
R^2=.79, F=48.48***			
Two-year lag model			
R&D	10482.88	.88	6.30***
R^2=.77, F=39.65***			
Three-year lag model			
R&D	10013.79	.86	5.71***
R^2=.75, F=32.58***			

*** $p < .000$

6.2 National Technological Capabilities, IT Use and Economic Growth

Next, a correlation analysis was done to examine national IT expenditure against GNP per capita in order to quantify the dynamic relationship between these two variables. Table 4 shows that GNP per capita is strongly correlated with national IT expenditure ($r=.88$, $p<.000$). This result suggests that increasing the level of national spending on IT may lead to a higher economic growth or that the level of economic development may be a key factor in national IT spending.

Table 4 Correlation and Regression Analyses of GNP per capita on National IT Expenditure, 1980-1995

r	R^2	F	B	Beta	T
.88***	.75	46.63***	15.23	.87	6.83***

*** $p < .000$

Table 4 shows that 75% of the variance in economic growth can be explained by the variable of IT expenditure ($R^2=.75$, $F=46.63$, $p<.000$). The regression equation is as follows:

$$Y=-24840.21+15.23X1$$

where Y=GNP per capita and X1=national IT expenditure. The result can be interpreted to mean that, if other influencing variables are ignored, the regression equation indicates that every NT dollar of IT invested tends to be associated with an increase in GNP per capita of 15.23 NT dollars. This result supports the findings of previous studies that a strong positive relationship exists between the increase of national IT expenditure and economic growth.

Multiple regression analysis estimates how much each independent variable contributes to economic growth (see Table 5). S&T human resources was first chose into the stepwise regression equations in both the current year model and one-year lag model. The results suggest, among other things, that the factor of S&T human resources is the best predictor of GNP per capita. The basic telecom infrastructure is another positive predictor of GNP per capita.

As presented in the two-year lag model and the three-year lag model, basic telecom is becoming a better predictor of economic growth over a longer period of time. The findings support the premise that it takes more time to build up telecommunications infrastructure and to capitalize on its returns.

Table 5 Multiple Regression of GNP per capita on IT Use and Factors of National Technological Capabilities, 1980-1995

Independent Variable	B	Beta	T
Variables in the stepwise regression (in the entered order)			
Current year model			
S&T human resources	18543.26	.83	7.145***
Enhanced Telecom	-35034.67	-.10	-3.07**
Basic Telecom	2753.56	.32	3.04**
IT Use	-1.22	-.07	-2.44*
R^2 = .99, F = 1664.30***			
One-year lag model			
S&T Human Resources	17579.85	.75	4.95***
Enhanced Telecom	-41165.66	-.11	-2.54*
Basic Telecom	3220.06	.35	2.50*
R^2 = .99, F = 948.23***			
Two-year model			
Basic Telecom	5342.72	.54	3.8**
S&T Human Resources	14121.00	.55	4.01**
R^2 = .99, F = 824.23***			
Y = -27748.76			
Three-year model			
Basic Telecom	6350.19	.61	3.59**
S&T Human Resources	13145.35	.47	4.01**
R^2 = .99, F = 811.73***			
Y = -25021.64			

* $p < .05$, ** $p < .01$, *** $p < .001$

The findings suggest that "S&T human resources" and "basic telecommunication services" appear to be the two best predictors of Taiwan's economic development. Although the study does not find that IT use presents a direct positive contribution to economic growth, it implies that the outcome of promoting IT-led development in Taiwan would be more manifest if the policymakers focused more on investing in telecommunications infrastructure and human training rather than on those measurements which encourage industries to spend more in IT. In other words, the effect of IT use on economic growth can be achieved only through a strong national information infrastructure that supports IT applications and use in Taiwan or in other Asian NIEs.

7. Conclusion

We may conclude that enhancing the level of national technological capabilities through the implementation of IT policies should lead us to expect a higher level of national IT use in Taiwan. The finding that there is a strong correlation between an increase in national IT use and economic growth is consistent with the notion of IT-led development. However, it does not provide conclusive evidence of a causal relationship.

This longitudinal study further suggests that the fruitful "production" of human resources in science and technology fields is the key to facilitating national IT use and to enhancing economic development. Another critical element of predicting economic growth is telecommunication infrastructure. Telecommunications networks would be considered as a key infrastructure component for IT-led development. Thus, investment in telecommunications should be integral to the national strategy of promoting IT use. This study asserts that IT-led development throughout Asian NIEs should be intensely promoted.

Taiwan's Information Industry Development Plan implemented in the 1980s and 1990s epitomizes how the government policy mechanisms enact the notion of IT-led development. Taiwan's NII project introduced in 1994 can be envisioned as a upgraded version of strategies for IT-led development which is converged with streamlined telecommunication infrastructures. Given the evidence shown in the multiple regression models, one can predict that the policymakers will need to put more effort into leveraging S&T human resources through training and increasing physical investment in telecommunications when Taiwan implements national information infrastructure as a strategy toward advanced development in the next century.

NII leaders from 20 Asian countries met in November 1995 in Bangkok to exchange hands-on experience and lessons learned in promoting NII. The conference concluded with the origination of an *Asian Information Infrastructure Declaration*. This will continuously promote the use of information infrastructure in delivering health care, education, electronic commerce, and government services in each country. It also identifies the need for harmonized standards and cooperation in the region. This paper supports one of the recurring themes that emerged from the Asian NII conference-- a strong, interconnected NII supporting IT applications would create a desirable environment for industries adopting IT. The need for upgrading IT human resources, in particular the "training of trainers," was viewed by the Asian NII leaders as another key to global competitiveness, in accordance with what has been empirically sustained in this paper.

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Is The Information Economy a *Sine Qua Non* For Economic Development?

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ABSTRACT

Is investment in creating an "information economy" a necessary condition to the efficient development of a modem economy in Low Income Countries ("LIC's")? Background is provided on information economics and the concept of an "Information Economy". The shift towards investment in information infrastructure in LIC's is described. The problems of measuring information transactions, and of distinguishing between correlation and causality in an information economy, are addressed. The effects of investment in information infrastructure are described, including rural areas. Examples are given of different national models.

I. INTRODUCTION

It is only three decades ago that economists started to consider the economics of information as a sub-discipline within the taxonomy of economics specialties. When it was realized that information plays a vital role in the production and marketing of goods and services, surveys were undertaken of different forms of information economies of developed and developing countries both by measuring the labor component and by measuring the sector component. But this still did not satisfactorily clarify the relationship between the "information economy", the "information society", and national development.

In 1995, Alvin and Heidi Toffler asserted in their book War and Anti-War[1] that "knowledge -- broadly defined to include data, information, images, symbols, culture and values -- is the central resource of the Third Wave economy. Once scoffed at, this concept has already become a truism". While knowledge is hard to quantify, it is today the most versatile and most significant of all factors of production. All this becomes possible because knowledge diffusion and applications grow with dynamic information technology.

This paper raises the important issue of whether an information economy is a significant engine of growth in Low Income Countries ("LIC's"). If so, does it guaranty uniform development of all sectors of society, overcoming imbalances both regionally and socially? What makes the information economy truly revolutionary in achieving the goals of development is, that unlike land, labor, natural resources and capital, information and knowledge are not finite resources and as such are inexhaustible. Information is a synergistic resource that feeds on itself and can be shared, stored and diffused without depletion.[2] With expanding investment in R&D, information technology devises newer and faster methods of knowledge dissemination to various parts of the world, so that the content can be applied unceasingly to the quest for economic growth and social justice.

Of course, technology, including information technology, is a means, not an end. It is not, in and of itself, a cure for all economic ills. It is one of many aspects of a nation's campaign to spur economic growth, industrial development, employment and quality of life.[3] It is a necessary, but not sufficient, condition of an expanding modem economy, itself dependent on other factors.

The focus of this paper is on reviewing aspects of the relationship between investment in information technologies, primarily telecommunications, and economic development in LIC's. A comprehensive discussion of all the connections between information technology and the legal, political, cultural and social spheres is beyond its scope. The examples from LIC's are illustrative only, and not meant to represent a survey of all possibilities.

2. BACKGROUND

2.1 Convergence

For the purposes of this paper, "information technology" refers to the now commonplace concept of the convergence of computers, telecommunications, electronic media and consumer electronics into an integrated national and global digital network. Telecommunications infrastructure is a key component of this trend, and, we believe, can serve as rough but useful proxy for the whole. Thus, when reference is made to research on the effects of investment in telecommunications, we are assuming this is a directional indicator for the larger complex of information technologies.

2.2 Global Collaboration As the Way of the Future

The call for global connectivity came from the Vice President of the United States at the ITU Conference on Developing Countries held in Buenos Aires in 1994, and from the ITU's Secretary General, Dr. Pekka Tarjanne, at Telecom 95. Countries around the world are being urged to prepare to connect to a Global Information Infrastructure (GII) as a way for better and speedier transmission and exchange of information.[4] Simultaneously, the ITU, with its 185 member countries, has supported WorldTel, an organization for funding the telecom requirements of LIC's. It is headquartered in London and subscriptions to its fund are flowing in largely from the affluent countries. The World Bank estimates that the LIC's will need some $90 to $120 billion by the turn of the century just to meet their basic telephone needs.

The emerging economies, especially those in Asia\Pacific, have recognized the importance of convergence. Profits loom large in the age of digitization, and joint ventures are being utilized to realize them as the way of the future. Such collaboration has proved successful in the use of submarine fiber pathways that link various continents. For example, the TransPacific Cable 5 (TPC 5) has been recently laid and is already fully subscribed. Only 33% of the investment came from AT&T, the rest from various other companies around the region like KDD, Singapore Telecom and others. The FLAG system started by Nynex now has several partners for its global links. For terrestrial lines, China is using ventures with Alcatel of France, Northern Telecom of Canada and AT&T of the U.S. for its digital switching equipment as well as for its fiber routes. Similarly for cellular systems, China opened its market to Ericsson of Sweden and Motorola for equipment using the GSM (Groups Speciale Mobile) standard.

Not only are these alliances helping the LIC's to obtain state-of-the-art technologies, but the advanced countries are making significant investments in the markets of the LIC's like Indonesia, Malaysia, Thailand, China and India. Deutsche Telekom has invested in the Indonesian satellite industry, as well as signed a letter of intent for an alliance with the Malaysian Technology Resources Industry which will bring in an Asian partner into Global One, which currently has US Sprint, France Telecom and Deutsche Telekom as partners. U.S. West has invested $1.8 billion in Malaysia's telecommunications sector, and Nynex has established a partnership for $9 billion with Charoen Popkhand of Thailand for a telephone network in greater Bangkok. Such collaborative arrangements abound Latin America as well, pointing to the strong trend for global collaboration as a first step towards funding and building the GII.

2.3 The Information Society and the Information Economy

The terms "Information Society" and "Information Economy" have sometimes been used in ways that suggest they are congruent, or at least significantly overlap. For the purposes of this paper, we regard the discussion of the "Information Society" to be primarily a sociological discussion, with various schools of thought emphasizing spiritual benefits (peace and harmony) or material benefits (more leisure time, improved products, better quality of life) or dystopian qualities (political, social or psychological dominance). The "Information Economy", on the other hand, refers to investments in information technologies, and the role of information in the economy, in traditional economic categories. From this perspective, there is no reason why countries with similar "information economies" might not produce dissimilar "information societies" due to differing non-economic factors.

3. DRAMATIC CHANGES IN LIC'S DEVELOPMENT POLICIES

3.1 Telecommunications as a Driver of Development

Until the late 1970's, telecommunications as a significant factor in economic development was largely overlooked. As a developmental tool, it was largely ignored by planners and theorists. It was grouped with public utilities and infrastructure, ranking below roads, power supply, water and sanitation as investment priorities. Telephones were looked on as a luxury, something for businesses and wealthy urban elites.

One of the most significant policy changes in LIC's in recent decades has been the priority assigned to telecommunications in national economic and social planning.[5] Clearly, LIC's have many pressing needs: physical infrastructure, health, education, sanitation, etc. All of these make demands on national budgets. Why then this relatively recent refocussing of

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resources? What is now seen as special about telecommunications and information?

About three decades ago, it began to be perceived in Japan, and then in the United States and other developed countries, that there was a shift in the center of gravity of the components of their Gross Domestic Products away from agriculture and manufacturing and towards the service sector, especially the information-intensive areas. This led to books by prominent sociologists and futurists announcing the "Post-Industrial Society" and the "Information Age". Since then, not only developed nations, but governments around the world have been seized with the belief that investment in the information sector will provide disproportionately large returns.

3.2 Huge Investments Underway in Telecommunications Infrastructure

At present, there is a massive flow of capital into this sector worldwide. Hundreds of millions of U.S. dollars will be invested in information infrastructure worldwide during the next decade.[6] This appears to be irrespective of ideology -- one of the largest investors will be the People's Republic of China, which has announced plans to spend US $10 billion per year to install 10 million new telephone lines per year. India, a "non-aligned" country, also is seeking to invest billions annually, largely based on non-Indian sources of capital. Concurrently, many of the developed nations are rebuilding and upgrading their domestic networks. Is this level of investment justified? Does what we know from theory and practice support the sponsors' expectations? We believe that it does.

For some, however, there remains a concern that, if the present level of telecommunication service in an LIC is sufficient, then massive investment in the premature expansion of a major infrastructure system would not only be a misdirection of resources, but would create a serious burden of unnecessary administration, training and maintenance. While this would appear to be an atypical case, more research on specifying the ability of an economy to absorb telecommunications investment could be usefully done.

3.3 Alternative Proposals Focus on "Delinkage"

There are also critics who see the potential for inefficient overinvestment as the least of this trend's problems. They believe these developments represent the continuation of what they see as a long tradition of the imposition of Western developmental models on non-Western LIC's. Based on this, some advocate a policy of "delinkage", that is self-reliance and internal development based on insulating a nation from the global economy. This may have, from its advocates point of view, a number of politically desirable results. But if economic growth is one of their goals, experience suggests it is an unlikely way to maximize it. Why is this especially true with respect to telecommunications and information technology? The answer is rooted in experience with this technology, and the fact it is not just another sector -- it has multiplier effects and positive externalities, which are described further below.

However, while experience in this area has shed some useful light on such effects, in important respects practice has gotten ahead of theory. The complex interrelationships involved make it difficult to offer a complete and consistent theoretical explanation for a phenomenon which is sensitive to so many variables that it is difficult to capture in a simple -- or even a complicated -- formula. A large part of the reason for this has to do with the nature of information, a problem we will explore here briefly, as traditional economics has struggled to come to grips with it.

4. INFORMATION ECONOMICS

4.1 Information's Limited Role in Neo-Classical Economics

Neo-classical economic theory is based on sets of testable hypotheses evolved over many years about things such as the nature of value, the working of markets, and the factors of production. It deals primarily with goods and services. Broadly speaking, the mainstream of modern economic theory has relied on an assumption called "perfect knowledge", the general proposition that the price of a commodity conveys all of the "information" a purchaser needs, so there is no theoretical reason to factor in a separate variable for information. Increasingly, however, some economists have been suggesting that not only is information a relevant factor in economic analysis, it is perhaps the major factor in the economy of the future.[7]

4.2 The "Peculiar Characteristics" of Information

The problem is that, in the literature, information is commonly described as having "peculiar characteristics". Economists are used to dealing with tangible commodities, like coal. A producer digs a certain amount out of the ground (leaving less than there was), transports it to market, and sells it at a market price. The seller has the money, the buyer has the coal. One load of coal is much like another. A fairly tidy transaction (with perhaps a few externalities like environmental degradation left over).

Information transactions, on the other hand, can be extremely untidy. Information is hard to define, behaves very unlike a normal commodity, is hard to measure, hard to value, and effects and is effected by external factors.

Information in the abstract, that is, separate from its embodiment in a physical medium (such as a CD or a videotape) is intangible. It is not located in space and is not subject to physical laws. It is used, but not consumed -- unlike a resource like coal, it is not depletable. It can be reproduced and shared without loss, and is unaffected by the number of people using it. The cost of production is independent of the scale of use. It can be retained after it is sold -- and on the other hand, it can be "taken" without the owner's knowledge.

Unlike a typical commodity, information defies uniform measurement and quantification. It is heterogeneous -- every unit of information is a special case. By definition, to be a commodity, an item must be standardized -- an observer must be able to determine what it is in a precise quantitative form, the units must be physically identical, and, when it has been exchanged, it must be possible to measure transactions. Information lacks any generally accepted standards of measurement, valuation, comparison or transaction.

Information is cumulative and synergistic, and both effects and is effected by external factors. The value of information is determined more by its quality than quantity, and depends on the subjective needs of the receiver based on context and timeliness. It behaves differently under different circumstances, and can have the characteristics of a resource, a factor of production, and a commodity. At the same time, it can add value to other factors of production, such as labor and capital.

In its disembodied form, it has characteristics of a "public good", that is, use by one does not diminish its availability for use by others. However, in its embodied forms, it can be a private good (one often stoutly defended). And, even more confusing, partial, incomplete, inaccurate or excessive information can be, in effect, a "public bad", having negative economic effects. Finally, and perhaps most troubling to many traditional economists, information has social power. Focusing solely on its economic aspect excludes its political, cultural, religious and aesthetic implications.

4.3 Modern Information Economics

"Information Economics" was not officially recognized by the American Economic Association until 1976 (in connection with "uncertainty" theory), even though in 1962 Fritz Machlup had published his seminal work, The Production and Distribution of Knowledge, Kenneth Boulding wrote about the "Knowledge Industry" in 1963, and Marc Porat's The Information Economy appeared in 1976. In 1972, Kenneth Arrow, who was awarded the Nobel Prize for Economics, was interviewed by *The New York Times* and stressed the information differential between economic actors and the cost of acquiring information as very important in organizational needs. Since then the role assigned to information in economics has responded not only to the use of new technologies, but to the deficiencies of economic theory in its application to the rapid changes introduced by information to decision making and a reduction in uncertainty. Economists now generally accept that greater informational efficiency makes for better utilization of scarce resources, minimization of effort and elimination of unnecessary duplication. While a beginning, this remains of limited value in analyzing the overall economic effects of information. Other areas were also explored.

As far back as 1970 Shackle had identified the process of a continual search for knowledge as the prime mover for production and exchange. Lamberton facilitated the study of information economics by publishing selected readings in 1971. Marschak in 1974 described the modern economy as a process of inquiring, communicating and decision making. Stocks and flows of information were recognized as determinants of organizational change.

Explicit models of the pricing of information were explored by Stigler in 1961 to demonstrate the market behavior of agents when information about prices is not known, and in the presence of uncertainty about the quality of the products by Akerlof in 1970. This analysis of market failure was moved to a study of the organization of production and distribution of goods and services as an important aspect of information economics by Jonscher in 1982. Whereas the economics of uncertainty is an analysis of how one adapts to uncertainty, the economics of information deals with how one overcomes it, according to Hirshleifer and Riley, 1979. Neoclassical economics assumed an optimal allocation of resources in a competitive market economy as part of a general equilibrium model. The very fact that commercial and consumer information is widely disseminated by the media is sufficient evidence to challenge this neoclassical model. Against this background of efforts by economists to integrate information into standard economic theory[8], we have to examine how these theoretical constructs apply to developing economies in their policies to join the bandwagon of the information superhighway.

While we are optimistic, there are limits. While the cost of information handling has declined over the last two decades, contributing to higher productivity, we cannot substantiate the statement made by Chaparro of the World Bank that information costs are falling to zero. The decline in cost is independent of the scale on which it is used, and the technological means of access to information often exhibits the economic property of a "club good", available only to members of the "club". In other words, equal access to information and connectivity are not yet available to "anyone, anywhere, any time". The user group is still restricted.

Lamberton emphasized the value of the information content as a vital element in corporate growth and microeconomic productivity[9]. He also asserts that a telecommunications infrastructure is not the same as an information infrastructure (see *Prometheus*, June 1996). Lamberton cites Stiglitz's overview of the current state of the economics of information in which there is a discussion of the limitations of considering information as a commodity. This is in contrast to the view taken by the FCC and other United States policy makers who maintain that information is like every other commodity in the market. As a consequence of the lack of a cohesive definition, Lamberton calls for a new taxonomy of information to replace the present general purpose concepts.

Other work done in the field of information economics is the study of investment in the information technology sector and its influence on economic growth in the developing countries (see Wellenius, Jussawalla, Hudson) as well as establishing information as a factor of production (see Braunstein). On the whole, as technology changes and its applications widen to include telelearning and telemedicine, economists are still catching up with finding explanations for embodying economic concepts into the overall framework of information technology. Notwithstanding remaining theoretical gaps, much can be learned from the teachings of experience.

5. OUTCOMES OF TELECOMMUNICATIONS INVESTMENTS

5.1 Correlation or Causality or ???

Since the 1970's, telecommunications and development research has been on the agenda of international organizations, nations, companies, banks, consultants and scholars. Studies have been conducted by the OECD, the ITU, USAID, UNESCO, and the World Bank, among others. These studies have addressed the profitability of the telecommunications service sector itself, as well as its impacts on other areas of the economy.[10] They have offered a number of working hypotheses suggesting a positive reciprocal causality between telecommunications and development, but one which is simultaneously interdependent with selected social and economic factors.

The question has often been put as one of causality vs. correlation -- does telecommunications contribute to development, or is the expansion of telecommunications a consequence of economic development? Clearly, there is a strong correlation between a country's wealth (measured in GNP and per capita income) and its investment in telecommunications, but which is the cause, and which the effect? As it turns out, good telecommunications systems appear to be a cause, a consequence and a manifestation of development. A related problem is that aggregate wealth may not fully measure quality of life throughout a society. Although it is often assumed that in most cases higher GNP and per capita wealth will correlate with quality of life indicators, such need not always be the case. With the increasing concern about meeting "basic human needs" and improving the conditions of the poor majority, additional indicators are required to give a more accurate reflection of the quality of life for all.[11]

5.2 Telecommunications as Sectoral Revenue Resource

Overall, domestic and international telecommunications entities in developing countries tend to be very profitable, with an average 27% rate of return.[12] Much of this "surplus" revenue is not reinvested in telecommunications, but is siphoned by the central government to support initiatives in other sectors. In addition to profitability, the value to the user in time and travel saved, and information acquired, represents a substantial economic benefit. Large economic returns also result from upgrading the telecommunications components in investment in other sectors (for example, railways, power, tourism and banking).

Proponents of such investments point out that as economic development takes place, some form of telecommunications gradually becomes the most cost-effective means of communication for increasing proportions of the population. Telecommunication services can substitute for other forms of communication (mainly postal service and personal travel) and are often more effective and more efficient than other forms in terms of time, energy, materials, and quality of the environment. The greater the distance, the greater the savings in travel costs and time in using the telephone.

5.3 Telecommunications as Multiplier

Improvements in telecommunications have significant direct multiplier effects across a wide range of economic activities. Not only is telecommunications a service sector in its own right, but is also a mode of delivery for many other services. It is also observed that with accessible and reliable telephone service, some of the physical constraints on organizational communication are removed, permitting increased productivity through better management in both the public and private sectors. Markets gain in effectiveness with improved communication, more rapid responses to market signals become possible, and access to market information is extended at the village, town, city , regional, national and worldwide levels. Also, the efficiency of household operation rises as telecommunications allows improved access to goods and services, and forms of work are supported that require some integration of workplace and residence.

Other reports indicate that there is virtually no aspect of economic and social development in any one sector of an economy that does not interact with that in other sectors. For instance, as agricultural development increases the marketable agricultural surplus, it gives rise to widespread trade in agricultural commodities, seeds, fertilizers, fuels and other goods and services, which, to be efficient, inevitably requires reliable means of communicating rapidly and over long distances. There is also a need for reliable and rapid information about weather conditions, disease outbreaks, and new agricultural techniques.[13]

The utility of telecommunications services has also been shown for commerce and industry. Industrial development requires coordination of numerous activities: acquisition of supplies, recruitment and coordination of labor, control of stocks, processing of materials, billing, record keeping, delivery of goods to buyers, and general market search activities. In the absence of an accessible and reliable telecommunication service such activities suffer a variety of inefficiencies. Even raw materials producers need better information systems.

To date, the findings generally appear to support the hypothesis that the effects of telecommunications do not accrue exclusively to the users, but accrue also to the society and the economy in general.[14] However, do the benefits apply equally? What about rural areas, where the majority of the population of the developing world lives?

5.4 Telecommunications Cost/Benefit in Rural Areas

In rural areas, revenues may not, at least in the short term, cover the capital and operating costs of the rural telecommunications system. Rural telecommunications are likely to cost more per capita and generate less revenue than comparable investments in urban or inter-urban services. Yet indirect benefits to users and to the rural economy as a whole may more than justify the costs. Telecommunications permits improved cost-benefits in rural social service delivery, such as rural education, agricultural extension information to subsistence farmers, and rural hearth care. Savings in training costs, labor costs, and transportation costs may justify significant allocations for telecommunications services. Rural telecommunications invites more equitable distribution of economic benefits, and telecommunications use can facilitate social change and improve the quality of life.

Similarly, evidence in many parts of the world indicates that telecommunications boosts morale of service workers posted in rural areas, such as teachers and nurses. There is evidence that availability of links to family and friends as well as for emergency assistance can contribute to lowering the rate of staff turnover in remote posts.

Finally, advocates of rural telecommunications investment stress that the direct contribution of telecommunications to individual and family welfare cannot be dismissed by derogatory references to "merely social" telephone calls. The well-being of the family is assisted by telecommunications, with the provision of rapid access to services often needed to preserve life, health and property, and with enhanced contact with kin, friends, and special interest groups. Telecommunications contributes to the development of a shared communication environment reaching a country's most remote areas, and it can facilitate political, cultural, economic and social integration.[15]

Some reports strongly suggest that the contribution of the telephone to economic development is particularly high in countries with very low telephone density (less than 10 telephones per 100 population), which tend to be the poorest countries. Thus, the lower the telephone density, it is argued, the greater the potential contribution of telecommunications investment to economic development, measured in increase in GDP per telephone. Thus rural and remote regions as well as the poorest nations, may stand to benefit most from telecommunications investment.

Studies also suggest that achievement of the full benefits of telecommunications in supporting economic growth is positively correlated to several other factors, that is, these factors are believed to play a major supporting role in realizing the benefits of telecommunications investments. They include urbanization, literacy rate, secondary education, research and development investment, openness of markets, open political systems, and the abilities of users. Correspondingly, the benefits can be reduced by political, social and economic structures that impair the system's efficient functioning.

6. MODELS OF TELECOM LIBERALIZATION AND SOME EXAMPLES FROM LIC's

6.1 Developed Country Models of Telecommunications Liberalization

Historically LIC's have had a range of problems related to telecommunications infrastructure investment, including insufficient capital, inadequate organizational structures and management, inappropriate equipment, poor maintenance, low salaries, etc. To overcome these problems, there has been a broad trend towards privatization and liberalization of domestic telecommunications markets to encourage the rapid construction of new lines, the development of new services, the lowering of prices, and more efficient operations. Models for this direction arose first in the developed countries.

Ever since the divestiture of AT&T and the Modified Final Judgment given by Judge Harold Greene, many countries with Public Telecommunication Organizations (PTO's or PTT's) have devised different policies for market reform for their telecommunications equipment and services. Natural monopolies were no longer justifiable on grounds of economies of scale and scope simply because the innovations in technology had made it impossible for vendors to change their organizational structures rapidly and for regulators to catch up with the sweeping new trends that were luring consumers. Major industries like banks, financial services, stock exchanges, airline reservation systems were converting to computerized operations and demanding ever more sophisticated systems for their electronic data interchange and transmission.

One model that caught the imagination of decision makers was that which evolved in the U.K., of duopoly to provide a competitor for British Telecom. Mercury together with Cable and Wireless was given that role, and an Office of Telecommunication was set up in the government to oversee these competitive arrangements. Whereas in the United States there was a clear demarcation of domestic and international communications between AT&T and the Bell Operating Companies (RBOC's), there was no such restriction on British Telecom or Mercury. Both companies could compete in both markets. In the actual working out of the competition, BT emerged as the dominant supplier with a near monopoly and Mercury, although it offered better and more modern services, lost out to the interconnection charges of BT. In international communications, BT International teamed up with MCI of the U.S. to gain a stronger position in Europe, whereas Cable and Wireless obtained its own partners to strengthen its grip on the markets of Asia and the Caribbean.

The Japanese deregulation of NTT was quite different in as much as it was directed by the Ministry of Posts and Telecommunications in order to make Japan more competitive in global markets. Japan already had its services clearly demarcated between domestic and international suppliers so that the privatization of NTT and KDD were both introduced by the same Business Law of 1985. While the shares of NTT were placed on the market to a limited extent, the new companies that were allowed to compete were fledglings trying to gain a foothold in the market already captured for decades by NTT. Even ten years after deregulation, NTT held over 65% of the market share and MPT was compelled to appoint a Commission to break up NTT into three divisions, to give a fairer chance to the new companies to compete. Likewise KDD was not forced to compete until foreign companies put pressure on the MPT to allow them to enter the market for international telecommunications.

The U.S. decided in 1996 to change its policies and create a free-for-all in the telecommunications sector by removing the demarcation of markets between local and long distance, as well as between telephone companies and cable operators. This is resulting in unprecedented mergers between the large and well-established suppliers and the mushrooming of new competitors in value-added and cellular services. The U.S. advocates and practices a largely free-market economy. But the conditions under which a free-market economy works in the U.S. are not similar to conditions in many other countries. Neither the American nor the Japanese model are directly applicable to each country in Southeast Asia. Even within that region there are disparities in the levels of economic growth and the aspirations of policy makers, with different theories as to how to use telecommunications to advance toward oriented strategies across diverse political doctrines.

6.2 Examples From Asia-Pacific and Other LIC's

Until 1993, Singapore espoused a fully centralized regime for its telecommunications organizations. Both Singapore Telecom and the National Computer Board were statutory bodies, yet both delivered the most sophisticated services to its citizens, making the island a center for multinational investment and technology transfer. Malaysia opted for a mix of public and private sector operations. The implications of liberalization are twofold and interrelated. First, the restructuring of the industry has an impact on all other sectors that use its services. Second, liberalization policies must be compatible with global market trends so that these countries can take advantage of new market opportunities.

For example, Malaysia pioneered privatization in the Asia Pacific region by placing its PTT shares on the Kuala Lumpur stock exchange in 1991. Since then the economy of the country has grown by leaps and bounds and a whole new cellular communications market exploded. The newly privatized Telecom Malaysia competed with new companies like Celcom and Atur 800, with Celcom obtaining the largest market share. The country has spent $4.5 billion in upgrading its fixed line services and in installing ISDN networks in major cities. Domestic companies like Sapura and Federal Cable are progressing with various contacts. On the whole, privatization has brought a 12% growth Malaysia's telecoms sector, as well as a new satellite system called Measat. In July, 1996 the Ministry in charge of telecommunications in Malaysia announced that it would create a level playing field for the industry by 1999. This underlines Malaysia's commitment to privatization and bringing lower costs to users. This has lured many foreign investors such as U.S. West and Deutsche Telekom International, which is investing in Technology Resources Industries, which owns Celcom.

In March 1995, the Thai government announced plans to privatize parts of two state-owned monopolies: the Telephone Organization of Thailand and the Communication Authority of Thailand. Under this plan, contracts will be awarded to private firms to install 1.9 million telephone lines throughout the country. Shinawatra, which holds the contract for satellites, is now the major supplier of the cellular networks. Telecom Asia, which is a $9 billion joint venture between Nynex and Charoen Popkhand, is laying two million new lines in greater Bangkok alone. Another company, Jasmine International, is installing another one million lines in the rest of the country. Thailand is targeting to increase its telephone penetration ratio from the current 5% to 10% by 1999, but is retaining 49% of the shares of all newly privatized companies. This indicates a different indigenous model of privatization which Thailand finds more suitable for its requirements.[16]

Latin America has become a laboratory for experiments in telecom privatization through a model relying on "strategic partners". These countries entered the decade of the nineties with heavy debt burdens, stagnating economies and high rates of inflation. They started privatizing state monopolies as a step toward debt relief and economic policy reform. Their telephone companies had suffered from underinvestment and poor earnings and their privatization started the region's economic revolution.

Privatization in Mexico, Argentina, Venezuela and Chile started around 1989-1990, and its impact on these countries is becoming clear. The first important policy change came in Chile when the local exchange carrier was sold to the Bond Corporation of Australia. The CTC (Compania de Telecommunicaciones de Chile) and the long-distance carrier ENTEL were both privatized. Entel's stock was owned largely by Telefonica of Spain since

1989. In the cases of Mexico, Argentina and Venezuela, the governments followed the same pattern of selling majority ownership of their PTT's to consortia including foreign and local partners. The new owners were given monopoly rights even over basic service markets and were required to meet certain performance criteria, in order to protect the rural areas. For example, Telemex increased the number of main lines by 12% a year and had to provide telephone to all localities with more than 500 residents. Likewise in Venezuela, CANTV has to install 3.6 million lines and 40,000 public telephones by the year 2000. Telmex had invested over $5 billion by 1995 for digital overlays to the network which involved the laying of 13,000 km of fiberoptic cables to cover 50 urban centers in Mexico. In Chile, telecommunications investment grew by 40% a year as a result of privatization, resulting in digitization of the entire network. While the new private carriers retain their monopoly over basic services, they face keen competition in value-added services from newly licensed operators, especially in the field of cellular systems.

Even the centrally planned economies like China and India are opening their markets in order to gain an entry to the global information superhighway. China in particular has loosened the grip of the MPT on the equipment and services markets through joint venture agreements with foreign operators like Alcatel of France, Ericsson of Sweden and Motorola and AT&T of the United States. China realizes that in order for its citizens and its businesses to become international in their relationships, they must have access to state-of-the-art communications. In the past, its policies were in contrast with those of the rest of Southeast Asia, but now we find that its policies are becoming more similar under the homogenizing influence of the information economy.

7. CONCLUSION

Experience suggests that investment in the "information economy", i.e., modern telecommunications systems, appears to be close to a *sine qua non* for the efficient development of a modern economy in LIC's. It remains, however, at least theoretically possible to overinvest, due to the technology's interdependence with other social and economic factors. Additional research would be helpful on that topic, as well as on the distribution of the benefits within an economy, and on how investment based on market-driven and command approaches compare. Finally, and far from least, the taxonomy and theories of information economics need to be better articulated to provide economic models for the consequences of these investments.

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Alternatives for Establishing Viable Rural Networks

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1. ABSTRACT

Technology capable of providing higher bandwidth networks to rural environments is allowing provision of voice, data and video services at lower cost. Simultaneously, policy choices previously unthinkable in monopolistic times are being considered to facilitate private capital infusion to finance rural networks. This paper surveys alternatives for resource mobilization and operator modes that can be used to significantly improve viability and accelerate rural development.

2. GENERAL CONCEPTS

Use of telecommunications and information technology is not limited to the needs of corporate users. Users are also villagers, farmers and agricultural workers, the unemployed, and remote contract workers. Services needed by users of information technology may be Internet access, remote educational materials, access to local, national and international media, nutritional, medical and agricultural information, electronic mail (E-mail), voice mail (V-mail), facsimile, and voice telephone service.

In addition to the traditional telephone company, potential providers of required network facilities include concessions, community cooperatives, community joint ventures, private network operators, local joint venture telephone companies, cable television providers, and others. The scope for different providers making available services to individuals is wide, and examples exist worldwide of different operator modes. To provide even simple information technology services in remote and rural areas, service providers must ensure services are located where people want them and provide the services people want. These lessons have been learned by nations that have funded "telecottages," only to see few of these survive after funding has been cut.

Decisions need to be taken, as part of a sector strategy, to set policies for a reasonable rural development plan. An example would be to provide at least one telephone in every village with a population above a certain size. Determining the minimum population size per village can be based on cost per line, income per capita in each village, and percentage of income typically spent on telephone service.

2.1 VIABILITY

A fundamental deterrent to rural telecommunications investment is lack of financial viability caused by higher capital cost requirements and lower revenue expectations. When viewed from a national perspective, a case in favor of economic viability can often be made because of the downstream direct and indirect benefits to the national economy as a whole. Minimal measurements of economic, as opposed to financial, rates of return are often derived by including adjustments for taxes, subsidies; and "shadow pricing" of labor and other inputs in the project cost and revenue streams. There is a growing awareness of the need to evaluate economic returns based on cost savings and revenue multiples, resulting in more realistic economic internal rate of return (EIRR) factors.

Costs may be driven down by mechanisms such as volume purchasing, competitive procurement, infrastructure sharing (such as, for example, electric utility company and/or rail company sharing of poles and rights-of-way with the telecommunications operator), system and equipment design innovation, and domestic manufacturing. Revenue may be raised by broadening the scope of services supported by a given infrastructure or facility, or by raising tariffs.

2.2 CUSTOMERS AND SERVICES

Decisions about defining who will receive what services are critical. Political, social, economic and financial agendas must be combined with a satisfactory and viable solution. These decisions cannot be taken in isolation from other decisions such as those relating to technology choices and network operator(s). In general, to maximize economies of scale, the largest possible number of subscriber groups should be targeted. To maximize economies of scope, the operator can bundle services which add value to network access for specific subscriber groups. Decisions about which customers and services to target should take into account:

- government policies and regulations;
- corporate policies and license obligations;
- funding limits;
- customer needs and expectations;
- facilities costs and estimated service/revenue mix; and
- orderly evolution to future services.

The public need for, and expectation of, communications facilities should be reasonably satisfied, at least in the longer term. Technology choices should be upgradable to support future enhanced functionality and wider menu of services which will be needed as economic development occurs and activities become more information intensive. Community surveys should be conducted to obtain local participation and data on specific subscriber groups in order to gauge the likely level of demand for access and usage.

2.3 SERVICE AND NETWORK EVOLUTION

The following is a possible evolutionary path for basic telephone service in a typical rural area:
(i) Public Calling Office lines only (PCOs);
(ii) PCOs plus a few subscriber lines to main business and government offices; (iii) use of small community exchanges in each community to concentrate long distance access and traffic, and to begin local exchange service; and (iv) relief of transmission and switching equipment to communities with significant demand by conversion to a full rural exchange or remote switching unit served by a separate radio system. This is illustrated in Figure 1.

Note that community exchanges can be wireless or wire-based, and hybrid combinations are now economically viable. Also note that the first three stages rely on expansion of the original radio-based infrastructure (which may be terrestrial or satellite). In the final stage, the infrastructure is displaced and may be redeployed elsewhere. The design objective is to provide efficient, flexible and cost-effective evolution to future services and networks.

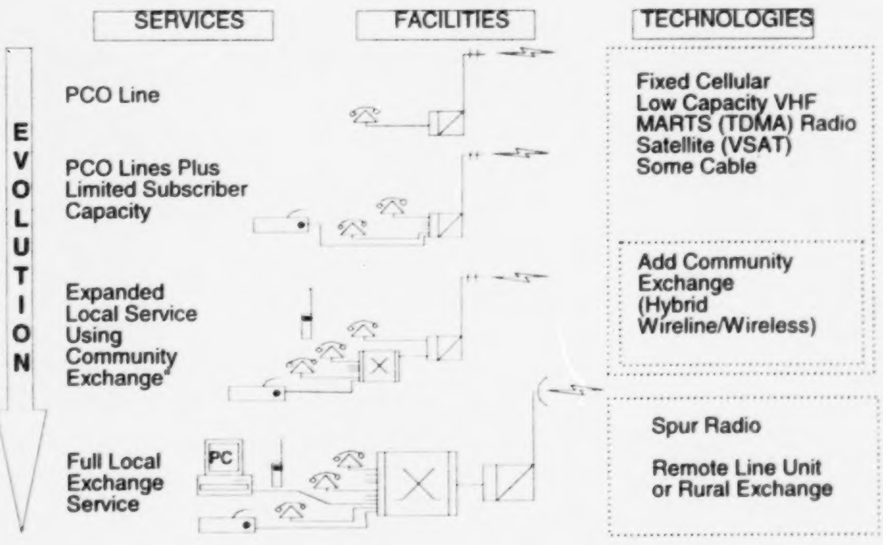
SERVICES
FACILITIES
TECHNOLOGIES
EVOLUTION
PCO Line
PCO Lines Plus Limited Subscriber Capacity
Expanded Local Service Using Community Exchange
Full Local Exchange Service
PC
Fixed Cellular
Low Capacity VHF
MARTS (TDMA) Radio
Satellite (VSAT)
Some Cable
Add Community Exchange (Hybrid Wireline/Wireless)
Spur Radio
Remote Line Unit or Rural Exchange

FIGURE 1. SERVICE AND NETWORK EVOLUTION

Depending on technology choices, and with some limitations, the following services can share some or all of the basic infrastructure:

- PCOs (with long distance access);
- subscriber lines (business and residential);
- pay phone (coin and card);
- mobile (cellular mobile, hand-held portables, dispatch service);
- facsimile;
- telex/telegraph;
- data service (E-mail, V-mail, image transfer, data base access, etc.); and
- teleconferencing, video conferencing and television (for entertainment, education, news and information).

2.4 LINE AND TRAFFIC ESTIMATES

The initial development of rural networks are often investment-constrained. In this case, demand forecasts are made to verify that projected supply will not overshoot demand.

Having established that investment will pace development, there is the question of who gets service first. Development priorities and selection should be a simple, just and relatively transparent process based on a weighted assessment of such factors as demand, expected revenue potential, potential for economic development, development of social infrastructure, population size, security, construction cost, and consumer surplus and cost-benefit ratios. The process should include consultation with national planning authorities, operators and local government units. Given a specific investment level, a rough estimate of the number of lines and locations to be served can be derived. The minimum number of lines initially supplied to any location should at least satisfy the need for public pay phones.

A traffic forecast for the subscriber network is needed to dimension concentrator-type subscriber access systems. Long distance traffic forecasts are needed to dimension facilities interconnecting with the long distance network. The average traffic for subscriber lines (business and residential) may vary between 0.01 to 0.15 Erlangs per line, with 0.1 being a common value. In the absence of reliable data, conservative estimates are recommended to dimension traffic-sensitive network elements (and less optimistic for estimating revenue in financial studies).

3. RESOURCE MOBILIZATION AND OPERATOR MODES

Given the scarcity of development funds in general and the uncertain financial basis that often accompanies rural development, funding a significant rural development program is difficult. The broadest possible set of sources of capital investment must be considered. Some of these include:

- revenue sharing concessions;
- joint ventures or strategic partnerships;
- rural co-operatives;
- rural joint ventures and cost-sharing arrangements;
- competitive entry by independent operators;
- competitive entry by existing private network operators; and
- cable television operators.

Choices regarding who will own, plan, engineer, implement and operate include government (national and local, as departments or state enterprises), private enterprise (large or small) and co-operatives. The choice is influenced by existing circumstances and settled by the philosophical leanings of the decision makers. If the private sector is involved in any capacity, it is vital that the role of government be clearly delineated. Policy setting and implementation are essential government roles. It is fair to say that the operator should be the owner, and that the operator should be involved in, and preferably take, full responsibility for planning the entire process, including engineering, tendering and contract administration.

Generally, state enterprises with fiscal responsibility and accountability make better operating organizations than government departments, which must put their revenue into the general fund and then budget operating and capital needs back out. Co-operatives, collectives, mutuals and other community-level organizations can be formed to construct and/or operate facilities. These can be effective mechanisms providing they have safeguards against low efficiency and they are properly supported (e.g., with technical and financial assistance). Co-operatives can be part of a logical and orderly evolutionary process that will eventually be phased out through acquisition by a larger national or regional operator.

One practical approach is to: (i) extend the PCO concept to include more diverse services, including community-based local exchange service; and (ii) obligate the long distance carriers as a condition of license to meet and interconnect with any PCO or other rural infrastructure inside its serving area. Diverse community-based development was used successfully in Japan and North America for early deployment of rural service. In India, extension of the STD Public Call Office franchising program to embrace this concept has been advocated. In Thailand, Indonesia and South Africa, among others, private individuals are permitted to operate PCOs.

Private sector participation in basic service provision, consistent with public policy objectives and legislative and constitutional requirements, may be warranted to close, to some extent, the funding gap. Telecommunications operators and responsible government bodies worldwide have embraced private investment in telecommunications networks under suitable regulatory regimes because, with very few exceptions, governments have been unable to develop the national telecommunications network at a speed commensurate with the public need for such facilities. This fact has imposed costs on the national economy—in the form of economic diversification, efficiency and productivity growth restraints—which are, at least partially, avoidable.

Mobilization of resources to the government from the telecommunications sector cannot be assumed to suffer as a result of private sector participation, because the faster the network development takes place, the larger the sector revenue. Many governments now view their role as being concerned with establishing an environment in which telecommunications development can occur more efficiently, at lower cost, and with fewer demands on limited public funds, rather than with providing the services themselves. Private sector participation does not necessitate the loss of sovereign control of the network, legislative and regulatory instruments which underpin network development, or government revenues from the sector.

The avenues for private sector participation in rural telecommunications development, apart from privatization of the national operator, include the following.

3.1 REVENUE SHARING CONCESSIONS

These include such arrangements as Build Transfer Operate (BTO) and Build Operate Transfer (BOT), and similar schemes. Under a BTO, the equipment supplier or other investor, often in an investment consortium, finances and builds a complete turn-key system (e.g., a regional network segment) and transfers ownership to, but manages and operates the network on behalf of, the national operator in exchange for a share of the revenues. Under a BOT, the investors finance, build and operate a project and transfer ownership to the telecommunications operator (or government ministry) at the end of a contract term. These schemes were pioneered in Asia (e.g., Thailand, Indonesia and Vietnam), though several BOT schemes have been concluded in Brazil and Colombia, and are being proposed in Paraguay, Guatemala and Venezuela. There are few examples of BOT/BTO projects specifically focused on rural areas. In most cases, the arrangements are focused on accelerating development in urban and suburban areas, although rural and semi-rural components are piggy-backed in some cases (e.g., Indonesia). One rural project in Colombia, involving Alcatel, provides a major regional infrastructure for 350 rural communities.

3.2 JOINT VENTURES OR STRATEGIC PARTNERSHIPS

Many countries allow up to 49% foreign (or at least private) participation in joint ventures, with national partners being either major industrial groups or the national telecommunications carrier. TeleNZ of New Zealand is understood to be providing rural service under a joint venture arrangement in Vietnam. Many joint ventures now exist in Central and Eastern Europe and in Confederation of Independent States member states. Most new market entrants in India are likely to involve joint ventures; the focus will be on statewide networks with rural service obligations. The Philippines also provides an example of joint ventures among private Philippine companies and international operators who must develop a specified number of exchange lines. In the Philippine model, the regulator requires that there be one rural line for every 10 lines developed.

3.3 RURAL CO-OPERATIVES

Subscribers or shareholders of rural co-operatives decide on the proportion of installation, monthly rental and traffic charges. Rural co-operatives have been used in Canada, the US, Finland and Bolivia. Some other Latin American countries have other forms of community-based cost sharing in rural areas.

Under a rural co-operative system, the dominant operator can assist in network design, equipment selection and procurement, installation and training, and interconnection to the national network. If provision for licensing and/or co-operative ownership of facilities cannot be established, the dominant operator can assume ownership of facilities after construction and acceptance testing, and compensate co-operatives for the initial investment by a reduced usage tariff. Areas served by the co-operative would be exclusive and would not duplicate or compete with the dominant operator's facilities, but would be aimed at service provision where none existed before. Services allowed would be based on the needs of the community.

3.4 RURAL JOINT VENTURES AND COST SHARING ARRANGEMENTS

Telephone operators may enter into associations at the community level with groups, including a local telephone agency, a business group (i.e., Chamber of Commerce), a farmer's cooperative or township/commune government. In some countries, various community and business groups have supplied almost all the capital required to finance the telephone development project. Typically, these associations finance the first one, or group, of lines using radio access technology.

Based on demand, traffic and revenue experienced as a result of the first line(s), the dominant operator may be in a position to justify its own separate and supplementary investment in a pay telephone, or perhaps in an extension of the existing radio system, to expand the service in the community. Such rural joint ventures have been established or are under consideration in Colombia, Brazil, Kenya and several other countries.

Under a rural joint venture or cost sharing arrangement, the community groups pay either all or a share of the first cost of initial lines. In cases where this has been attempted, business subscribers have been willing to pay connection charges well in excess of official tariffs to gain access to the network. As in the case of a rural co-operative option, the dominant operator can examine the feasibility of extending the network or adding supplementary facilities such as pay phones after operation has started, based on demand, traffic and revenue. If provision for licensing and/or co-operative ownership of facilities cannot be established, the dominant operator can assume ownership of facilities after construction and acceptance testing, and compensate the community groups involved in the rural joint venture for the initial investment by a reduced local traffic tariff.

3.5 COMPETITIVE ENTRY BY INDEPENDENT OPERATORS

Competition in rural areas may dilute private investor interest due to market size considerations. Nevertheless, the competitive entry model—more specifically, the credible threat of competitive entry—has been shown to spur network development by the existing dominant operator dramatically (such as in the Philippines and Hungary, for example). In Argentina, competition in rural areas is reported to have been a significant factor in the lowering of per-line cost and prices. The Government of India has recently decided to allow second operators to compete with the Department of Communications on a state-by-state basis. New entrants will be expected to maintain a balance between urban and rural operations under their terms of licence. The new Philippine system involves duopolistic competition between newly licensed carriers and the dominant carrier throughout the country on a territory-by-territory basis. Examples also exist in Sri Lanka and Mexico where governments have allowed new entrants based on innovative (non-wireline) technical solutions, including fixed cellular and VSAT networks. Some of these may represent an extension of a corporate network to provide service to the public and interconnection with the PSTN.

3.6 COMPETITIVE ENTRY BY EXISTING PRIVATE NETWORK OPERATORS

These may include power, railway, bank or resource companies. Power companies have been active in the development of competitive network options in the US and Britain, while the major rail companies have been instrumental in developing

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Canada's second long distance network. In China, competitive entry is coming from other government agencies combining to form alternative carriers. In most situations, the companies or government agencies involved in this mode begin with data and private line voice communications.

Organizations with existing networks which have been cost-justified for their own corporate needs could afford to extend service to rural communities within their areas of operation. The offering of VSAT solutions for public voice applications in Mexico, Brazil and the CIS comes from this direction. A potential new entrant in Sri Lanka will cost-justify the investment, at least partially, on the basis of major corporate need. The extension of networks initially designed for corporate data applications to serve voice customers and to offer enriched data services is now becoming a reality. Some of these services could be made available economically to rural communities in areas which have business and industry customers nearby.

3.7 CABLE TELEVISION OPERATORS

Since the entry of community antenna television (CATV) operators into the competitive telephone service arena in Britain, followed by the US, there has been a great deal of interest in the ability of CATV operators to achieve scope economies which are beneficial to both cable TV and telephony subscribers with a combination of fiber optic backbone and "switched star" network topology, as well as ultimately providing a feature-rich range of multimedia (bandwidth-intensive) services on the same facility. Some operators in this class (notably US West) are promoting mixed technology solutions comprising: (i) a CATV backbone; (ii) cable-based subscriber access for high-use customers and those within the core service area; and (iii) fixed cellular technology for lower-use and perimeter customers.

This type of solution has been proposed by US West for India and is also being used in Hungary and Poland. The application is for district centres and new industrial zones with substantial surrounding rural areas. It is noteworthy that, in some countries, CATV companies are serving new subscribers at a faster rate than the telephone company. Our experience in the developing world indicates that subscribers with low incomes may be more inclined to purchase CATV service as a means of family entertainment when the family budget cannot support the installation and subscription cost of both CATV and telephone service. CATV networks, therefore, potentially can provide not only lower per-line cost due to economies of scope, but also future enhanced multimedia services and marketability benefits.

In summary, Figure 2 integrates operator modes as alternatives for sector finance and operation, as well as the implied ownership, market structure, main regulatory issues and minimum services to be offered.

4.0 TECHNOLOGY SOLUTIONS

In general, technology decisions should strive to minimize life cycle costs while maximizing revenue potential and minimizing risk. This section briefly addresses each of these aspects.

4.1 MAXIMIZING REVENUES

To maximize revenue potential, technology platforms should support as many different services as possible, particularly those which can easily share some or all of the same infrastructure and those that serve complimentary markets. The following is a list of representative services that can, depending on specific circumstances, share infrastructure with and/or complement basic telephone service.

- Interactive Voice Response—Allows telephone callers to perform remote functions (e.g., retrieve information, check account balances, pay bills, order items) by selecting from prerecorded menus.
- Print-On-Demand—Use of integrated voice response systems to remotely request documents to be sent by facsimile.
- Voice Mail—Recording, storage and retrieval of voice messages over a telephone system.
- Paging—One-way signaling of simple coded messages to small pocket-size radios.
- Mobile Phone—Portable and transportable telephone service (e.g., cellular).
- Facsimile—Transmission of pages with text or images.
- Electronic Mail—Exchange of text and computer files (as attachments) from computer terminals (e.g., PC).

- Information Search and Retrieval—Use of a computer terminal (e.g., PC) to find and retrieve ("download") information, usually over the Internet and, increasingly, the World Wide Web.
- Education Entertainment Television—Use of broadcast television to distribute one-way or two-way ("interactive") video signals for use in educational applications (e.g., distance learning) and for entertainment.

Examples of infrastructure sharing include fixed wireless local loop being offered with cellular mobile service, and television for education or entertainment sharing some facilities with satellite-based voice telephony stations. Examples of complementary services include offering paging with V-mail and regular telephone service. Government regulations, although relaxing in most parts of the world, can limit which services any given operator may offer.

MARKET ENTRY OPTIONS	**OWNERSHIP**	**MARKET STRUCTURE**	**MAIN REGULATORY ISSUES**	**SERVICES**
CONCESSIONS	Public under BTO Private for fixed term under BOT	Exclusive in service area	Tariffs and adjustments, interconnection, quality of service targets, line build targets, frequency management for wireless, subscriber equipment approval, conditions for revocation of licence	Voice, low-speed data, initially small menu of VAS
JOINT VENTURE/ STRATEGIC PARTNERSHIPS	Shared public and private		As under concessions plus possible revenue sharing formulas	
RURAL CO-OPERATIVES	Can be public, or shared public and private	Exclusive in unserved areas		Primary voice, low-speed data and limited VAS
RURAL JOINT VENTURE/ COST SHARING	Shared public and private	Exclusive in service area	As under concessions, plus possible revenue and cost sharing formulas	
COMPETITIVE ENTRY BY INDEPENDENT OPERATOR	Private	Competitive	Tariffs should be set by competitors Tariffs should be cost-based to establish a level playing field Interconnection should be mandated	Voice, low-speed data, initially small menu of VAS
COMPETITIVE ENTRY BY PRIVATE NETWORK OPERATOR				
CATV		Competitive (CATV operators)	Tariffs should be set by competitors Quality of service targets should be specified Interconnection should be mandated	Voice, low-speed data, initially small menu of VAS, TV broadcast

FIGURE 2. MARKET ENTRY OPTIONS, AND MAIN POLICY AND REGULATORY ISSUES

4.2 MINIMIZING COSTS

A large part of minimizing costs involves selecting the most appropriate technology for the specific situation. In addition to the traditional rural solutions, there are some new and some evolutionary products emerging from the current drive toward wireless and mobile technology that are providing new options. The following is a list of technologies relating to personal communications service (PCS) that have potential to reduce the future cost of rural telecommunications.

- Terrestrial-Based High-Tier PCS—These technologies provide relatively wide area coverage (several kilometers to a few tens of kilometers) and generally have a lower transmission rate. DCS 1800, PCS 1900 and CDMA are examples, as well as the digital cellular standards including GSM and D-AMPS.
- Terrestrial-Based Low-Tier PCS—These technologies tend to have shorter range (a few hundred meters to a few kilometers), but have higher transmission rates and may be better adapted to use with higher rate data services. DECT, PACS and PHS are examples.
- Satellite-Based Mobile Satellite Service—These include Inmarsat Standard M products and regional services, including those available in North America (MSAT) and proposed for Asia, and are based on geostationary orbit satellites.
- Satellite-Based Global Personal Communications Satellite Service—These include the proposed low and mid Earth orbit (LEO and MEO) satellite systems that have been allocated spectrum. One or more of these systems should become operational before 2000.

Although wireless access has the potential for low cost, particularly as volume production for urban applications drives down cost, issues of subscriber terminal power and radio range need to be considered when used for rural service.

4.3 MINIMIZING RISK

The choice of technology should minimize risk. Ideally, a small group of candidate technologies should be derived initially from planning studies. Standardizing on a small group of technologies (but not necessarily on proprietary vendor equipment) will foster higher volume equipment orders, improving economies of scale and competitive supply. Comparisons between contending technologies and configurations should be based on discounted cash flow methods, including operation, maintenance and expansion costs. Other criteria to guide the selection process could include, for example:

- preference for open standards for equipment and systems;
- modular designs that have maximum flexibility for expansion and ease of redeployment;
- low power consumption and optional integrated standby power subsystems for use where commercial power is unavailable or unreliable;
- ascertaining adequate spectrum is available in suitable frequency bands;
- integration of different new technology, and new technology with existing technology (compatibility); and
- reliability and maintainability.

In general, minimizing costs and diversifying the services that can be supported will minimize risks. Use of very old and very new technology both carry similar risks of technological isolation and lack of long-term support; the very old because it is losing market to newer, successionary technology, and the very new because it may fail to succeed in the market.

5.0 CONCLUSION

The greater menu of alternatives for viable rural telecommunications networks allows today's planners to more closely tailor organizational and technical solutions to specific situations. This can significantly improve the degree of success achieved. However, these choices come at a cost to the planner; specifically, more analysis is necessary to sort through, select and optimize the alternatives. A process to arrive at a successful rural telecommunications development strategy should be comprehensive and consider the host of interrelated factors. In this way, we can arrive at solutions that are appropriate and optimized for each country's unique circumstances.

Public Telephony via Mesh DAMA Systems

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Abstract

SCPC DAMA technology has been applied to both public and private voice and data networks. Typically, quite different network architectures are used to support different levels of applications. For instance, inter-exchange, or infrastructure, networks that connect public telephone switches may offer full mesh connections. But, SCPC DAMA VSATs that provide "last mile" local loop connections into PSTN Central Offices (CO's) usually rely on a "star" architecture that pushes switching and routing functions out to terrestrial public network equipment. Ultimately, though, the infrastructure and local loop segments must play together in an integrated network delivering toll quality voice at the lowest possible recurring service cost. This paper presents an innovative network architecture that blends both infrastructure and local loop services into a single integrated, scaleable VSAT network that is ideally suited for PSTN service in developing and sparsely populated regions.

Introduction

This paper describes a highly scaleable thin route DAMA public telephone *inter-exchange infrastructure* network that grows to provide switched and routed *local loop customer premises* service. This unique network concept brings the benefits of satellite networking to the lowest levels of the public telephone hierarchy. An enduring, mass market VSAT public telephone service must provide affordable, toll quality voice with only one satellite hop. We'll show how this innovative architecture differs from other satellite solutions, and how it improves voice quality and reduces the total cost of delivering end-to-end service.

Satellite links have long been used in public network infrastructure. The infrastructure approach has been top-down, starting with heavily used thick routes. As equipment prices decline, VSATs become candidates for customer premises equipment (CPE) for public local loop services. The local loop CPE is applied bottom-up, reaching out to connect individual subscribers to central offices via a satellite "last mile" connection. But, there is a gap between the two approaches. Top-down infrastructure systems provide full mesh connections, but are limited in the maximum number of subscribers and call transactions served. Their architecture does not scale to vast numbers (hundreds of thousands, or millions) of CPE users. Conversely, the satellite "wireless local loop" networks use a "star" architecture to attach many, many CPE subscribers to a pre-defined PSTN central office. But, then they rely completely on the PSTN for all switching and routing - even to connect CPE VSATs to each other via a switch at the star hub. Such systems are scaleable only by replicating many different independent "stars". This architecture forfeits the substantial routing benefits that an infrastructure "switch in the sky" DAMA network brings to interconnect regional networks.

The purpose of this paper is to discuss the technical issues involved in bridging this gap between the top-down inter-exchange networks and the bottoms-up local loop VSATs. First we present an overview of the two types of networks. Then we'll show how an SCPC DAMA system can be used to create an integrated networking environment.

Inter-exchange Networks

A simple infrastructure network is shown in Figure 1 - Inter-exchange Network. Note that in this example there are no customer premises VSATs. Satellite is only used for switch to switch connections.

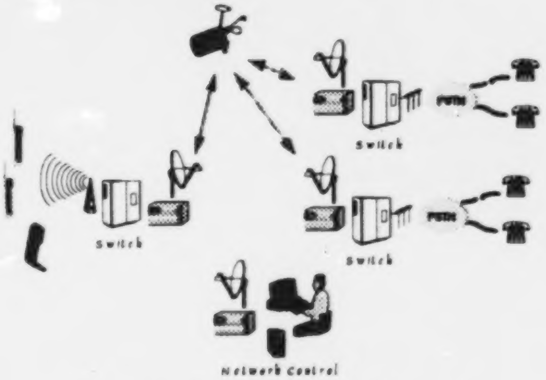

Figure 1 - Inter-exchange Network

A number of different satellite networking options are available. These are listed in Figure 2 - Multiple Access Options.

Technology	Description	Attributes
Dedicated	• Fixed, pre-assigned satellite links • SCPC or MCPC	• *Does not adapt to traffic load* • *Requires dedicated equipment for each link*
Multi-Carrier TDMA	• Medium or high speed TDMA • Demand assigned by circuit or trunk group	• *Requires all subscribers to support TDMA burst rate* • *Penalizes single carrier CPE local loops*
SCPC DAMA	• Demand assigned by circuit	• *Rates adapt to traffic* • *Minimum transmission rate for smallest sites*

Figure 2 - Multiple Access Options

The simplest option is fixed assignment, dedicated SCPC or multiplexed MCPC to connect central offices. There are also multi-carrier TDMA (MC-TDMA) networks that use burst rates of several Mbps to switch trunk groups or subscriber lines among central offices. More recently, SCPC DAMA systems offer circuit-by-circuit connections using low cost VSATs. The point of all these systems is to minimize infrastructure costs by connecting hard-to-reach switching offices to each other, or to strategically located PSTN entry points.

SCPC DAMA is attractive because it can be economically applied to the lowest levels of the network, while still preserving single hop direct connections to higher levels in the hierarchy.

Local Loop Service

Local loop networks provide the "last mile" from a telephone central office (CO) to the customer's premises. Wired and wireless terrestrial local loops *only* connect the subscriber to a pre-determined CO. VSATs have been proposed to link subscribers to a CO, as shown in Figure 3 - Satellite Local Loop. Local loop traffic is much different from inter-exchange service. Infrastructure networks serve tens to hundreds of sites with relatively high usage per line. Satellite local loop networks have orders of magnitude more subscribers. Ultimately they should serve tens to hundreds of *thousands* of sites(or more), each with comparatively low usage per line.

SCPC DAMA is attractive because it minimizes the transmission rate from the VSAT to the CO, allowing a smaller earth station than would be needed with a TDMA inbound link. But, most satellite network architectures usually mimic the terrestrial local loop by only connecting a VSAT to a pre-determined CO. That is, there is no way to route a call from a VSAT to a different CO, except through the PSTN. This is an SCPC "star" architecture, using a different multiple access technique than TDM/TDMA VSATs, but with similar limitations. Star local loops preclude single hop VSAT-VSAT links, as well. Basically, star local loops avoid switching and routing the high volume of telephone call transactions by passing that problem off to the terrestrial PSTN. Star "DAMA" is just used to establish a link to a known CO - not to create a single hop satellite link to the best available destination satellite terminal.

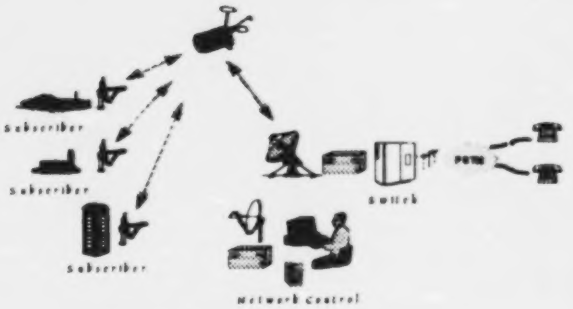
Subscriber
Subscriber
Subscriber
Switch
PSTN
Network control

Figure 3 - Satellite Local Loop

Star local loops are "scaleable" in that many independent stars can be connected via the terrestrial PSTN, as shown in Figure 4 - Multiple Star Local Loops. Each local loop could link, say, ten thousand sites into the PSTN via a predetermined CO. Then ten CO's would serve, say, one hundred thousand customer sites.

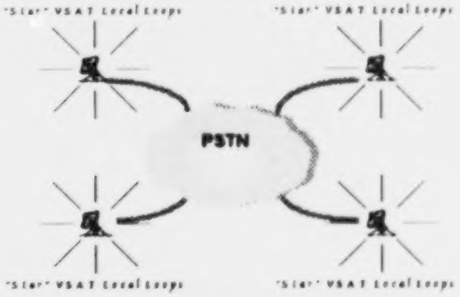
"Star" VSAT Local Loops
"Star" VSAT Local Loops
PSTN
"Star" VSAT Local Loops
"Star" VSAT Local Loops

Figure 4 - Multiple Star Local Loops

There are some obvious disadvantages of the multi-star architecture. One is that a satellite hop is required for each CO to CPE VSAT link. This is a unique problem for VSAT, compared to terrestrial twisted pair or wireless local loop, because of the quarter second propagation delay for a VSAT hop. This means that the star architecture requires 2 hops for a VSAT-to-VSAT call, even within the same CO. Figure 5 - Multi-star 2-hop connections - shows how multi-star architectures use 2 satellite hops to connect satellite phones through the CO switch at each hub. This is true for satellite phones that are "local" to the same CO, or satellite phones located on "distant" CO hubs. Multi-star discourages using infrastructure VSAT to interconnect the CO's – since that would add still another satellite propagation delay. Sparsely populated and developing regions that benefit from satellite "last mile" service, also need satellite-based infrastructure. The star local loop model requires a richly connected terrestrial system to complete calls to the PSTN. Inadequate or unreliable terrestrial infrastructure can block calls even when the satellite local loop is available. But satellite infrastructure adds another satellite hop even for VSAT to PSTN calls. The delay introduced by two hop calls is widely perceived as disruptive and would probably encourage subscribers to seek alternative phone service.

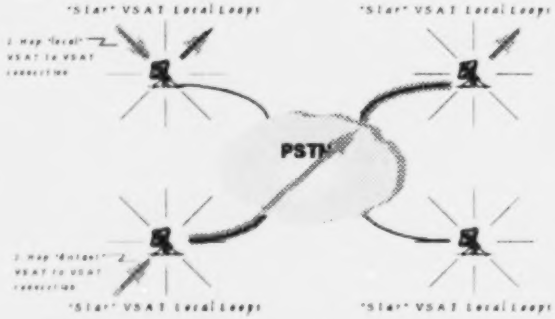
"Star" VSAT Local Loops
"Star" VSAT Local Loops
2 Hop "local" VSAT to VSAT connection
PSTN
2 Hop "distant" VSAT to VSAT connection
"Star" VSAT Local Loops
"Star" VSAT Local Loops

Figure 5 - Multi-star 2-hop connections

Integrated Networks

There is a straight-forward solution to bridge the gap between the top-down infrastructure networks and the bottom-up local loops. By focusing on the switching and routing software one can handle both customer premises and inter-exchange traffic in a single, integrated, scaleable satellite network capable of connecting hundreds of thousands of users to the PSTN and each other with single hop service. The concept is shown in Figure 6 - Integrated Inter-exchange & Local Loop.

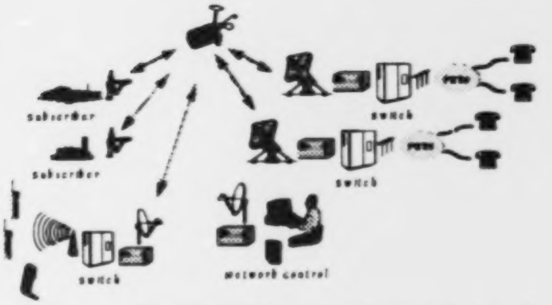

Figure 6 - Integrated Inter-exchange & Local Loop

The DAMA network control system can create single hop satellite links that make any needed connections:

- VSAT to the "best" CO switch based on each dialed number and current network loading conditions.
- VSAT to VSAT direct single hop
- Switch to switch - also based on each dialed number and current network loading conditions.

The single hop connectivity is shown in Figure 7 - Single Hop Mesh Network. In contrast with the multi-star architecture each of the CPE VSATs is not forced to connect only to its CO. A CPE VSAT can make a single hop connection to other VSATs, or to the optimal CO. Plus, the network can also carry CO-to-CO traffic.

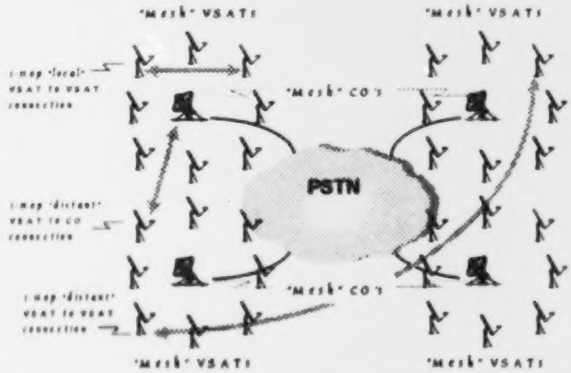
"Mesh" VSATs
"Mesh" VSATs
1-hop "local" VSAT to VSAT connection
"Mesh" CO's
PSTN
1-hop "distant" VSAT to CO connection
"Mesh" CO's
1-hop "distant" VSAT to VSAT connection
"Mesh" VSATs
"Mesh" VSATs

Figure 7 - Single Hop Mesh Network

The next section lists some of the important features needed in the integrated VSAT telephone system.

System features

The system must combine key features of both infrastructure and local loop networks.

- Toll quality voice coding with minimal throughput delay. For a system to integrate with the PSTN, the voice coding algorithm is subject to "tandems" - i.e. multiple voice digitization with different algorithms. ITU G.728 and G.729 standards are medium and low rate algorithms that integrate well with public digital networks.
- Rapid call set-up time, typically about 3 seconds or less.
- PSTN switching system protocols for the target operating areas. This may include both analog and digital central office interfaces. It may also require inter-networking to translate protocols between exchanges using incompatible formats.
- A telephone numbering plan that integrates with the public network. The numbering system must recognize and route country codes, area codes, and local exchange conventions.
- Dynamic directory and routing tools and algorithms that deal with a constantly evolving PSTN. Routing tables should provide alternative satellite ground entry points in the presence of congestion or outages.
- Scaleable multi-transponder operation to support very large networks and high call transaction rates, without sacrificing connectivity or call set-up delay. *A large system may have to process tens of thousands of call transactions per minute.* The network architecture must be able to distribute this load among many different real time DAMA CO's, linked together

by a common, synchronized subscriber and routing database.

- Fail-safe redundancy (local and geographically remote) that preserves ongoing calls, billing database consistency and network loading status - even in the presence of computer software or satellite terminal failures.
- High density carrier packing technologies that support the greatest number of simultaneous voice trunks on a single satellite. Advanced modulation, coding, adaptive power management, and other techniques are needed to optimize throughput. This has two big impacts: (1) directly affects the recurring cost per minute of the satellite segment, and (2) determines the population size that can be directly connected via a single satellite hop.
- Security and authentication to prevent unauthorized terminals from "pirating" free time on the network.
- System management tools to observe and control the telephone network.
- Extension to bandwidth on demand & advanced data services such as video conferencing or Internet access.

System Architecture

The integrated network environment consists of four types of earth stations. These are shown in Figure 8 - Earth Station Types.

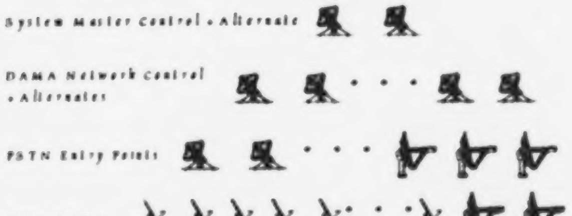
System Master Control + Alternate
DAMA Network Control + Alternates
PSTN Entry Points
CPE VSATs

Figure 8 - Earth Station Types

The purpose of each type of earth- station is described below:

- Master Control: Maintains the master subscriber and routing database. Synchronizes and distributes databases for all of the real-time control terminals.
- DAMA Network Controllers: Each one manages real-time DAMA connections for one satellite transponder. Each controller handles up to 1000 call transactions per minute. All controllers are connected to each other and the master via a Wide Area Network.
- PSTN Entry Points: These are subscriber terminals that are located at PSTN Central Offices (CO's). They can handle inter-exchange (CO-to-CO) or local loop (CPE-to-CO) traffic. The earth stations at the PSTN entry points are sized (antenna diameter and SSPA) based on the number of trunks they serve.
- CPE VSATs: Serves individual subscribers. CPE VSATs may be sized to handle from 1 to 16 or more trunk lines and can interface directly to telephone handsets or to a PBX.

Summary

SCPC DAMA systems are evolving to serve public telephone networks from two different directions:

1. Top-down, by serving inter-exchange infrastructure traffic. But, generally, these systems do not scale to handle mass market CPE subscribers.
2. Bottom-up, by serving local loop CPE VSATs with a star architecture. Multi-stars scale to handle mass markets, but push switching and routing out to the PSTN - forfeiting the advantages of mesh infrastructure.

The gap must be bridged to create a truly ubiquitous mass market for fixed site VSAT public telephone service. The benefits of an integrated local loop and infrastructure architecture are improved voice quality, lower recurring costs, and greater availability. These are achieved by:

- Enabling single hop connections for VSAT-VSAT traffic.
- Providing free, integrated long distance service for VSAT to PSTN traffic by directly connecting each CPE VSAT to the optimal PSTN entry point with only one satellite hop. Call completions are enhanced by dynamic routing to bypass congestion or outages.

Comparative Approaches in Implementing Wide Area Satellite Networks

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Abstract - Tremendous growth has occurred in the assimilation of the Internet into everyday business operations over the past 18 months. Furthermore, greater demands have been placed on traditional LAN/WAN connectivity methods for higher speed access to geographically dispersed servers and client applications. Various satellite based solutions have recently emerged to address this emerging need for greater speed and higher capacity in accessing the Internet and enterprise wide server environments. There are a number of key differences in these systems that have a substantial impact on implementation cost, system effectiveness and the success of the network in meeting user requirements and expectations.

This paper educates users and buyers of satellite systems to assist them in understanding the fundamental tradeoffs involved and equip them in making an informed rational decision for their particular LAN/WAN and Internet access application. In addition, a new approach in demand based wide-area networking is presented and contrasted to the available systems in the marketplace.

Introduction

Internet and multimedia applications have experienced tremendous growth in recent months. Just as new software applications seem to have an undaunted appetite for more computer memory and disk space, information consumers have an unending desire for vast amounts of information, at a faster access pace then ever before. Money is starting to flow through cyberspace as well. Despite major concerns over security, industry analysts say Web commerce totaled $436 million last year.

No business, institution or agency wants to be left behind in the technology information age. Internet service providers are finding homes in Mali, Malaysia, and Bolivia. Many are turning to satellite to provide the necessary access backbones to the Internet and stores of multimedia information. Corporations are interconnecting geographically dispersed server networks. Educational institutions are communicating across countries and cultures, sharing libraries and databases of research information.

Internet and Multimedia by Satellite

Satellites are ideally suited for interconnecting these widely dispersed servers and for providing local access points to the high-speed Internet infrastructure located thousands of miles away. Over the past 18 months, savvy system integrators and service providers have installed dedicated point-to-point single channel per carrier (SCPC) links to connect local point of presence (POP) servers to Internet gateway points. As seen in Figure 1, these satellite links essentially establish full-time medium speed (64 to 256 Kbps) data conduits between the Internet and the local access point.

Users are connected directly to the access server over a local area network (LAN) or via dial-up telephone lines that connect to the public switch telephone network (PSTN). Users located within the PSTN simply dial the telephone number for the port server, which connects their 9.6 to 28.8 Kbps line to the wide area network (WAN) port of the server. A PPP, SLIP or TCP/IP connection is established from the user terminal back to the Internet gateway.

The link from the client site is used to request files, home pages, video clips, etc. and to high-speed access to multi-site servers. Service providers can offer higher service quality levels to clientele, yet do so at reduced operating costs thanks to the magic of intelligent DAMA networking.

Clearly technology doesn't stand still, nor do the people who make use of it. The real challenge is not how to keep pace with, but rather how to harness it and use it in ways that go beyond the obvious. DAMA networking can provide this leap forward and bring performance that goes beyond the traditional wired networks that we are familiar with today.

[illegible]	SCPC	[illegible]	SCPC DAMA
[illegible]	√	[illegible]	√
[illegible]	√	[illegible]	√
[illegible]		[illegible]	√
[illegible]		[illegible]	√
[illegible]		[illegible]	√
[illegible]		[illegible]	√
[illegible]		[illegible]	√

Table 1 - Summary Comparative Matrix

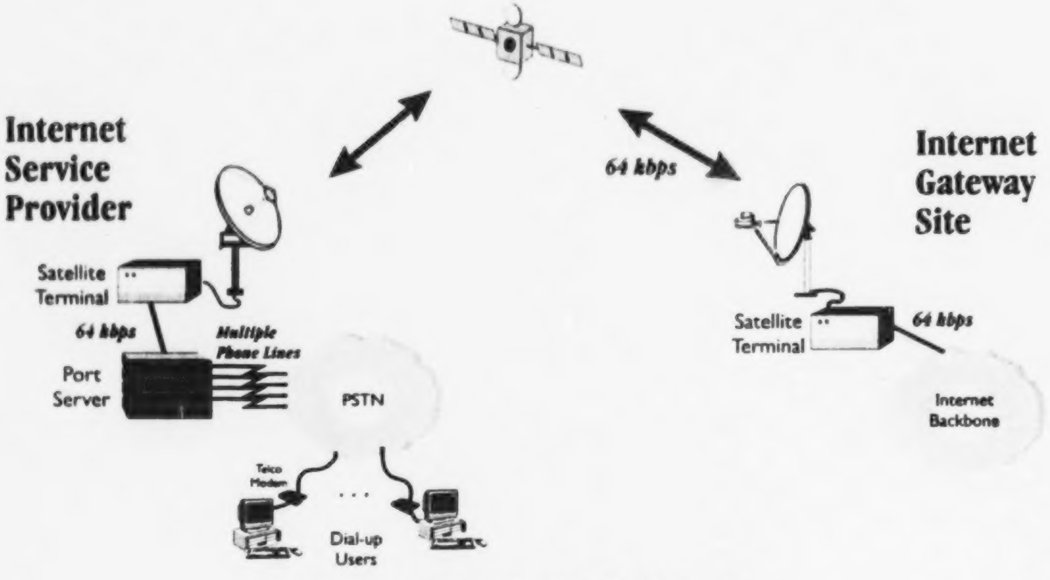
Internet Service Provider
Satellite Terminal
64 kbps
Multiple Phone Lines
Port Server
PSTN
Telco Modem
...
Dial-up Users
64 kbps
Internet Gateway Site
Satellite Terminal
64 kbps
Internet Backbone

Figure 1: Dedicated SCPC Network

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provide a return path for the appropriate protocol. The link from the gateway to the client is used to transport the requested data. At any one time there may be several IP sessions occurring at the same time, with the router at either end providing session management. This configuration is relatively simple to implement and operate and can bring service to areas that otherwise would wait months or years for wired infrastructure. In fact, end-users will not even know that satellites play a role in making their connections.

Characteristics of Web and Multimedia Server Transactions

Taking a closer look at this arrangement one can make several observations that impact the service provider's operating costs and, for power users, can affect throughput performance.

First, almost all web browsing traffic and multimedia server transactions are much more traffic intensive from the server to the end-user than in the reverse direction. Typical traffic ratios for Internet browsing is 10:1 outbound to inbound loading as seen from the server/gateway prospective. Thus, equal (symmetric) satellite links are not necessary. More effective use of the satellite resources can be made by operating asymmetric links. With the 10:1 number in mind, an outroute of 256 Kbps with an inroute of 19.2 or 32 Kbps might be more appropriate.

The amount of bandwidth required in either direction is heavily influenced by the amount of traffic required to serve local users, whether by LAN or dial-up connections. If full-time fixed rate circuits are used and traffic loads vary widely, then there will be times when there is insufficient capacity (and user response is slow) and times when capacity is in abundance (little loading means wasted bandwidth and excess operating costs). For a single service site the variance in loading is difficult to mitigate. From the user's perspective, too much bandwidth is preferable so that response time is quick.

Second, for networks where there are multiple service or client sites, the use of dedicated links from the gateway to POP sites is very inefficient and costly. To connect the sites, the gateway must have dedicated hardware for each site and dedicated space segment is required for each connection as well. The changes in user loading discussed earlier occur on a site-by-site basis. With dedicated connections each link is independently operated. However, by pooling satellite and equipment resources into a single network the variances in loading can be aggregated among all sites. For example, when user demand drops for sites A and D and demand increases at site B, the excess capacity from A and D can be used to meet site B's traffic load. This resource sharing can be very cost effective and provide enhanced service performance to the end-user if implemented properly.

Resource Sharing Technologies

There are two resource sharing technologies that are available and apply to Internet and multimedia networking. These are TDM/TDMA VSAT and SCPC DAMA. Both of these systems have been around for a number of years, with VSAT having the greater longevity of 10 years plus.

Traditional VSAT Networking

Figure 2 shows a Very Small Aperture Terminal (VSAT) network providing service to several different types of sites. As previously depicted there is the Internet service POP site providing wireline dial-up access to end-users. Also shown are the corporate access sites with access via a LAN, and single client sites where direct serial connections can be made to the VSAT terminal.

For the outbound traffic from the Internet gateway, capacity sharing occurs using time division multiplexing (TDM). A single 256 or 512 Kbps data pipe is time shared among a large population of users (IP sessions to any or all sites). Each IP session is allocated by the system a portion of the total outbound bandwidth, typically 16 to 32 Kbps. The return path is provided by time sharing a single RF channel, using a technique called time division multiple access (TDMA). In this case the individual portions of bandwidth are much smaller than the outbound channel. Special protocols are used to support this time sharing technique. These protocols are in addition to the TCP/IP protocol that carries the data traffic.

Without going into the specifics of how these protocols interact, overall performance can vary widely. While connectivity is possible, it can come with severe penalties in low throughput rates (because of high protocol overhead) and significant throughput delays. The better implementations do not directly encapsulate TCP/IP packets within the standard X.25 packets that VSAT's are famous for handling.

By design TDM/TDMA VSAT systems are hub-centric, meaning that all traffic passes through the central hub site. This traffic pattern may be acceptable for a single Internet gateway, but for services that have several or many multimedia server locations that need to be accessed by users, this limitation is significant. The servers must be physically located at the hub facility or permanent "backhaul" connections made from the server sites to the hub. For educational networks that span various universities geographically separated, these types of hub "work-arounds" are not viable. What is desired is that any server in the virtual network can be accessed quickly and transparently by the end-user.

Additionally, the VSAT system is a significant investment in infrastructure. VSAT hubs have much larger antennas than the remote sites, use high power amplifiers and require a substantial investment in hardware and software to operate. Hub costs, depending on configurations and the speed and number of outbound/inbound channels, are 30 to 200 times more expensive than their SCPC counter parts (of Figure 1), and 200 to 1,000 times the cost of the remote VSAT terminal. Thus a large number of remote sites are needed to justify the infrastructure cost in this type of system.

VSAT systems were designed to be effective in transporting small amounts of occasional data that is associated with automated teller machines, credit card validation, point-of-sale and inventory applications. The higher bandwidth, more constant connections needed to support Internet and multimedia users are a bit of a stretch for the traditional VSAT systems. While they can provide a reasonable level of service if fine tuned to the application, there is a solution that can provide significantly better performance at far less expense.

SCPC DAMA Networking

Enter SCPC DAMA systems that have been in use for over five years. These systems can be viewed as a hybrid between a SCPC point-to-point system (Figure 1) and the traditional VSAT system (Figure 2). Connections are made on a point-by-point basis between any two nodes in the network using SCPC carriers. These connections are made based on user demand with key attributes like service type and transmission rate based on need.

The overall control structure is similar to the VSAT system in that the allocation of the resources, service attributes, and the administration of the system are provided by a central controller. Communication between the remote terminals and the control site use the same TDM/TDMA VSAT type channels but at low data rates (like 19.2 Kbps) since only control traffic is carried.

The key distinguishing feature of SCPC DAMA is that the service connections are made directly between any site in the network. These connections can also be full-duplex equal rate, unbalanced rate or even one-way broadcast (one to all) or multicast (one to many) if desired.

Figure 3 presents a multigateway and multiserver network for Internet and multimedia clients located at various types of sites. The

Internet outbound channel now operates at rates of 256 to 2,048 Kbps, so throughput can be up to eight times faster than the VSAT approach. This wide-band one-way channel is shared among all Internet user sites with individual sessions having access to the full-bandwidth, and not predefined bandwidth slots as in the VSAT solution.

If even greater capacity is desired, then multiple 2 Mbps carriers can originate from the Internet gateway. By using IP routing tightly coupled with DAMA network processing at the uplink(s) the overall network load can be balanced among the various outbound carriers. This concept provides true "virtual" network operation and substantially better performance than a "hardwired" network where users are placed into predefined groups, each being allocated to individual outroutes.

Higher speed means faster response times for the end-user. Using a single 2 Mbps channel, a 3 Mbyte multimedia file can be transferred in times as short as 15-20 seconds! This performance level is not currently possible with terrestrial wired services. Furthermore, these large capacity channels are time shared among all users in the network, so users are charged only for the portion they use.

To complete the service connection, a return link is established from each remote site. Since this channel services only one site, the data rates can be much lower than those used in VSAT systems. Depending on the traffic loading at the user site, data rates can vary from 9.6 to 64 Kbps. With low speed return channels, very low power (1/4 and 1/2 Watt) RF equipment can be used, thereby decreasing the cost of the DAMA terminal significantly.

Advantages with Integrated DAMA Routing

The transport channels are just a portion of the solution however. At the each user site, the data needs to be routed and interfaced to the end-user LAN, POP port server or individual work station. By integrating the remote router function into the terminal a number of benefits are derived. Equipment costs are lowered, end-user equipment is directly connected to the DAMA terminal, and installation and maintenance costs are reduced. Furthermore, special processing can be implemented in the integrated router function such that TCP/IP operates more efficiently. When transporting TCP/IP over satellite channels the throughput capacity is limited due to the effects of increased transmission delay on the acknowledgment protocol used. This limitation typically restricts a single TCP/IP session to an effective throughput of approximately 400 Kbps, even if channel capacity is 2 Mbps. Using special processing techniques, this limitation can be mitigated permitting throughput above the capacity ceiling. With special attention to design, this compensation can be implemented transparently with no impact on user applications. Transparency to end-user off-the-shelf applications is an exceptionally important attribute and unfortunately it is a point that is sometimes overlooked by vendors. Using special compression techniques the return channels can be implemented with lower bandwidth than typically needed while supporting the higher outbound capacity.

Further performance gains can be achieved by tightly coupling the IP routing function with DAMA. Return channel capacity can grow as necessary to very closely match the demand at any one site. Recall the earlier discussion with fixed links and varying traffic loads. Often times there is either excess capacity or capacity shortage. End-users quickly perceive the shortage due to much slower response times. With DAMA, the return channel can be implemented at a nominal rate of 19.2 Kbps for example, and when loading increases, a second higher speed channel, say 64 Kbps can be established without user or operator intervention. If demand increases yet further, than the first channel can be re-established at a higher rate. This bandwidth growing technique currently exists in some flavors of remote access

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routers used for terrestrial dial-up networking. Coupling this feature with DAMA satellite channels makes for a very powerful, yet cost effective networking solution that goes far beyond existing satellite based networking solutions.

To further increase system efficiency and lower operational costs special compression techniques can be used on the return channels to lower the amount of bandwidth required. TCP/IP header compression can decrease the necessary bandwidth by a factor of four. This means lower return channel rates which directly relates to lower cost RF equipment and less bandwidth required on the satellite.

Flexible Networking

With the flexibility of the DAMA system architecture, a single network can be put together that can provide both public access (e.g., Internet connections) as well as private enterprise wide intranet (e.g., file servers, multimedia servers, etc.). This type of connectivity can be seen in Figure 3. Users sitting at terminals connected to the LAN at the corporate access site can launch a Netscape browser to surf cyberspace or run FTP (file transfer protocol) to download an assortment of files off a distant multimedia server. Furthermore, other types of services can be added to the DAMA terminals to provide telephone, fax, and video conferencing connections. When needed, the infrastructure can grow far beyond the initial networking application to meet a host of other communications needs.

Capacity is also easily scaleable in the SCPC DAMA network. For each gateway/uplink site the transmission rates and number of carriers that are implemented is based solely on the traffic load originating from that site. New networks can start small with a single 256 or 512 Kbps carrier. With the addition of equipment the uplink can support 8 Mbps of capacity or greater. Remote sites can operate one or more low to medium speed return links, again based on traffic loading for that site.

A final note regarding the DAMA system shown in Figure 3. The network billing and system administration functions can be located at any site in the system, unlike the VSAT system of Figure 2, where it must be located at the hub. This is significant if the network is being operated by a provider who has all gateway nodes located on customer premises as might be the case in a co-operative multinational university network.

Comparative Summary

Table 1 provides a comparative summary of key attributes for the three technologies. These characteristics include transmission speed and capacity, flexibility and connectivity, resource management and growth, and infrastructure cost. A SCPC backbone is the simplest to implement, is relatively inexpensive for very small (1-6 sites) networks yet can provide a wide range of operating rates. Because of its low complexity it's not amenable to expansion nor can it easily adapt to load changes.

The more advanced VSAT system provides a greater degree of flexibility and adaptability for larger size, low to medium speed, networks. Yet it is encumbered with a more costly hub-spoke infrastructure that doesn't easily support the multiserver networking environment. While it is expandable, greater capacity is achieved at relatively high additional cost.

The SCPC DAMA solution brings a new dimension to client-server networking. It's fast access and high transmission rate capability provides performance to users that can surpass the "plugged-in" world of terrestrial networking. Advanced capacity management can provide a higher level of service reflected by quick responsiveness even during peak usage times, an attribute that is difficult to achieve in the traditional wired connections. The high degree of flexibility in making connections anywhere in the network gives users essentially transparent

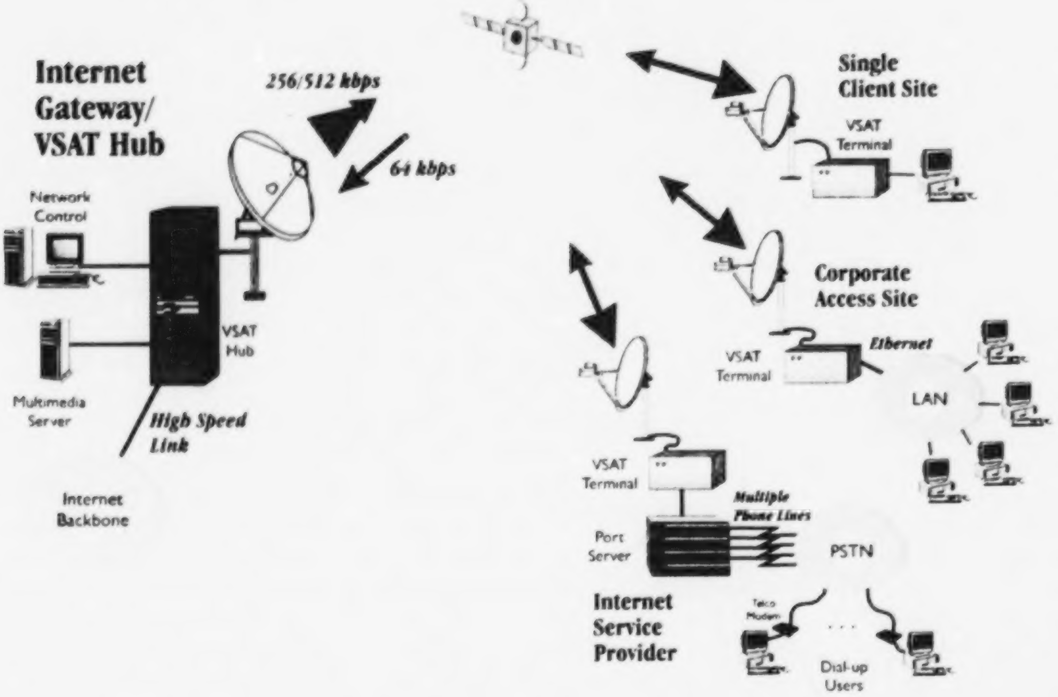
Internet Gateway/ VSAT Hub
256/512 kbps
64 kbps
Network Control
VSAT Hub
Multimedia Server
High Speed Link
Internet Backbone
Single Client Site
VSAT Terminal
Corporate Access Site
VSAT Terminal
Ethernet
LAN
VSAT Terminal
Multiple Phone Lines
Port Server
PSTN
Internet Service Provider
Telco Modem
Dial-up Users

Figure 2 - VSAT Based Multimedia Network

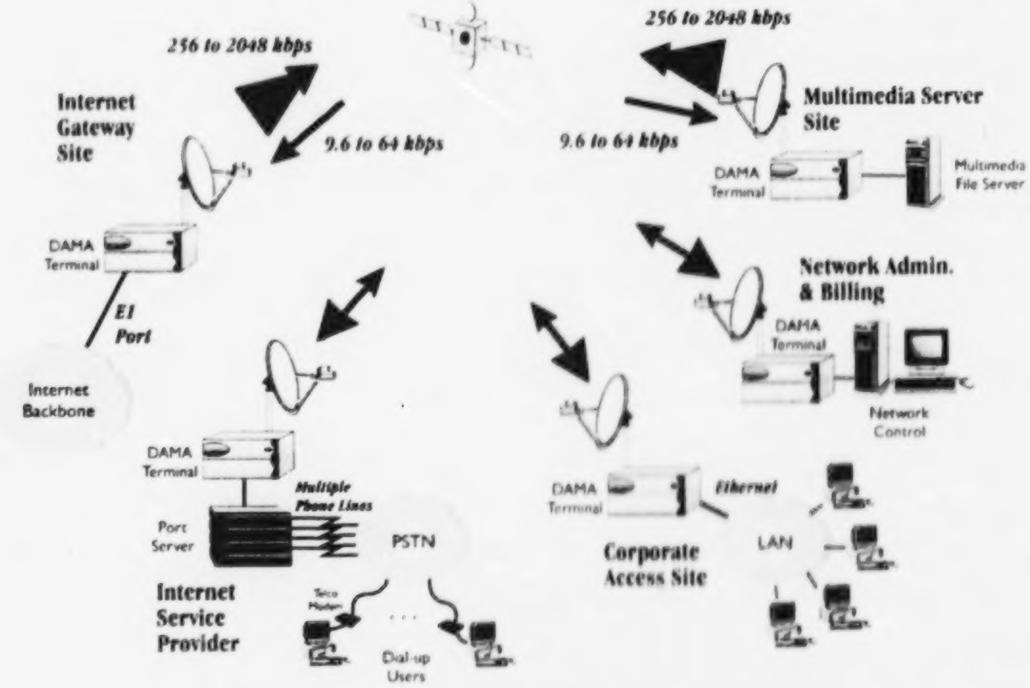
256 to 2048 kbps
9.6 to 64 kbps
Internet Gateway Site
DAMA Terminal
E1 Port
Internet Backbone
256 to 2048 kbps
9.6 to 64 kbps
Multimedia Server Site
DAMA Terminal
Multimedia File Server
Network Admin. & Billing
DAMA Terminal
Network Control
DAMA Terminal
Multiple Phone Lines
Port Server
PSTN
Internet Service Provider
Telco Modem
Dial-up Users
DAMA Terminal
Ethernet
LAN
Corporate Access Site

Figure 3 - SCPC DAMA Based Multimedia Network

Analyzing the Benefits and Constraints of Satellites for Digital Television Transmission

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Abstract

Digital Television, with its higher quality picture and, with compression, lower transmission costs, is seen as almost revolutionary in its potential. Reality has been more prosaic than the original euphoria over the benefits of digital compression and transmission. There are both benefits and constraints associated with this new technology. These are discussed below from an Asian region satellite operator's point of view

1 - Introduction

One year ago, at PTC '96, Dr. Pekka Tarjanne gave a speech on the Internet as part of the global information infrastructure. One of the points he made was that Internet users are highly concentrated (97%) in the high-income countries. An accompanying graph showed the distribution of Internet users, main telephone lines, and television sets among high income, upper middle income, lower middle income, and low income countries. While Internet users and main telephone lines are concentrated in the high income countries, television is relatively evenly distributed. About one-half billion television sets are distributed among about three billion residents of low income countries. This suggests that about half of all households in low income countries have a television set. Television is probably the most ubiquitous form of communications in the world today with a reach that encompasses almost the entire population of the globe.

In 1945 when Arthur C. Clarke envisioned a system of geosynchronous satellites above the equator, he expected their primary function to be television broadcasting. Fifteen years later, when communications satellites were being planned, they were seen as devices for point-to-point communications--replacements for the submarine telephone cables. It was not until the appearance of domestic communications satellites in the mid-1970s that television distribution became the primary function of communications satellites. From that time to today, television has dominated satellite communications.

Until the 1990s, satellite television was exclusively analog. In the last few years digital television has become more common--especially compressed digital television. At about the same time that the orbital arc was becoming crowded, a new technology which allowed multiple television channels to be carried by a single satellite transponder entered the market. The table below shows actual (1994 and 1996) and predicted (1998 and 2000) growth of analog and digital television transponder use on AsiaSat and some of its Asian regional competitors:

AsiaSat and Competitors Television Transponder Usage

Type/Year	1994	1996	1998(est.)	2000 (est.)
Digital Transponders	1	18	60	120
Analog Transponders	44	78	115	120

In what follows we will attempt to describe the benefits and constraints associated with using satellites to broadcast digital television signals.

2 - Satellite transmission

Satellite transmission, due to its point-to-multipoint nature, provides the most cost effective method for distribution of TV programming to populations spread over large regions. Compared to terrestrial channels, Satellites have relatively large bandwidths. For example, the Fixed Satellite Service (FSS) has 800 MHz available at C-band and 750 MHz at Ku-band. With this bandwidth, a large number of channels can be accommodated. The typical transponder Equivalent Isotropic Radiated Power (EIRP) will soon be about 40 dBW for C-band and 55 dBW for Ku-Band. The major constraints will be adjacent satellite interference and rain fade in the high frequency bands (>10 GHz). The following gives a detailed analysis of these problems.

2.1 - Adjacent satellite interference

The regional economic boom and the success of satellite TV in the past few years, has driven more and more organizations to file for orbital slots and launch satellites. The geosynchronous orbit (GSO) is getting more and more crowded. On the other hand, satellites with higher power, wider coverage and more transponders are becoming the norm. As a result, satellite networks are now more likely to interfere with each other. Adjacent satellite interference has become the central parameter in satellite network design. Especially when small receiving dishes are used, such as TVROs for the reception of satellite Digital TV.

Typical satellite spacing over the Asia-Pacific Region, varies from 2 to 3 degrees. Assuming all satellites are homogeneous (same power levels, etc.) and equally spaced 2.5° apart, we can derive a typical satellite downlink signal-to-interference power ratio (C/I) versus TVRO dish size at C-band and Ku-band, as shown in Fig. 1. In comparison, the typical carrier-to-thermal noise (C/N) ratios are also shown in the Fig. 1. Clear sky conditions are assumed for the Ku-band link.

It can be seen that within the range of dish sizes of interest and low link availability, the link performance is essentially dominated by the adjacent interference. The interference environment in practice may be different because the assumption of homogeneous satellites may not always true. For a minimum C/I ratio of 2 dB, it can be seen that the required dish size will be 1.5 meter for C-Band and 0.5 meter for Ku-Band.

2.2 - Ku-band rain attenuation

Rainfall can severely attenuate satellite links, especially at Ku-band. Basically, the rainfall affects the satellite links in three ways. It attenuates the radio signal strength, increases the receiving earth station equivalent noise temperature and changes the polarization of the radio signal. Rain attenuation and depolarization depend not only on the rain fall intensity (mm/hour), which is expressed as a function of the percentage of an average year in which the rate is exceeded, but also on the earth station elevation angle and signal polarization, which are functions of the receiving station location with respect to the satellite. Fig. 2 shows the rain zones in the Asia/Pacific Rim. From zone A to zone P the rain intensity increases. The typical rain zones are K, N and P with typical rainfall intensity exceeding 42, 95 and 145 mm/hour during 0.01% of an average year. For example, the rain attenuation in Hong Kong located in zone N, is shown in Fig. 3. For services requiring high availability and good error performance, large antenna size will be needed. There exist several effective techniques to counter rain fade. The most popular method is the uplink power control (UPC) technique which automatically adjusts the earth station transmit power to compensate for rain attenuation. In order to guarantee good availability, the antenna must be large enough to have a wide dynamic range. Site diversity is also an effective way to increase link availability.

3 - Standards for Digital TV broadcasting

A typical satellite digital television transmission system comprises one or more uplink earth stations and millions of Integrated Receiver/Decoder (IRDs) terminals or Integrated Receiver/ Transcoder terminals (IRTs). The

Figure-1 Carrier to Interference (C/I) and Signal to Noise (C/N) Ratios versus antenna size

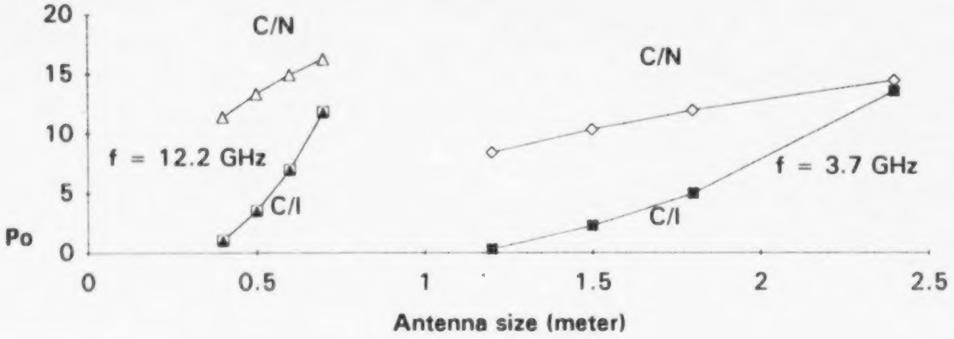
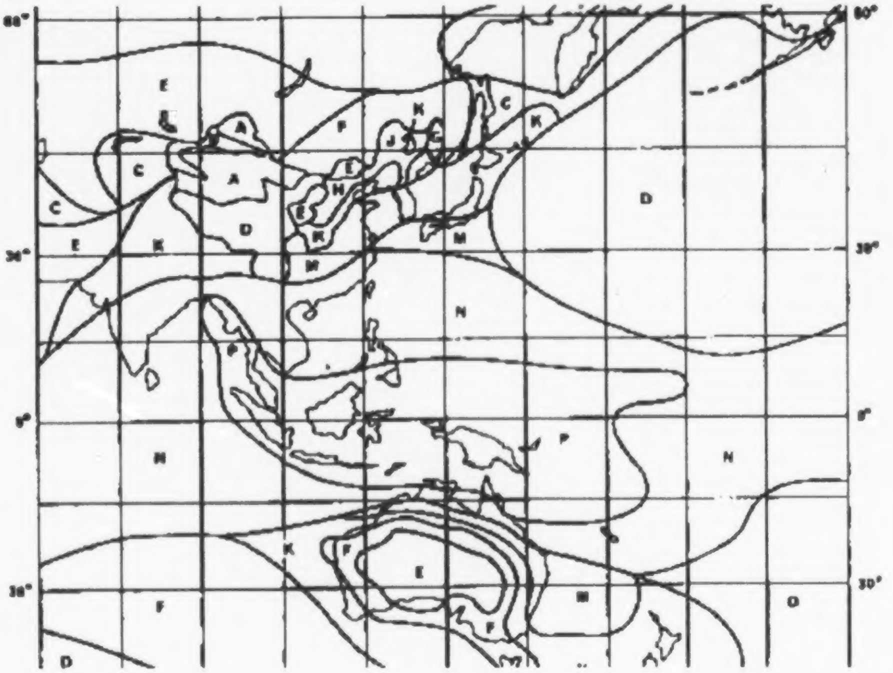


Fig. 2, Asia-Pacific Rainfall climate zone map


60°
30°
0°
30°
E
C
A
F
K
J
C
K
D
E
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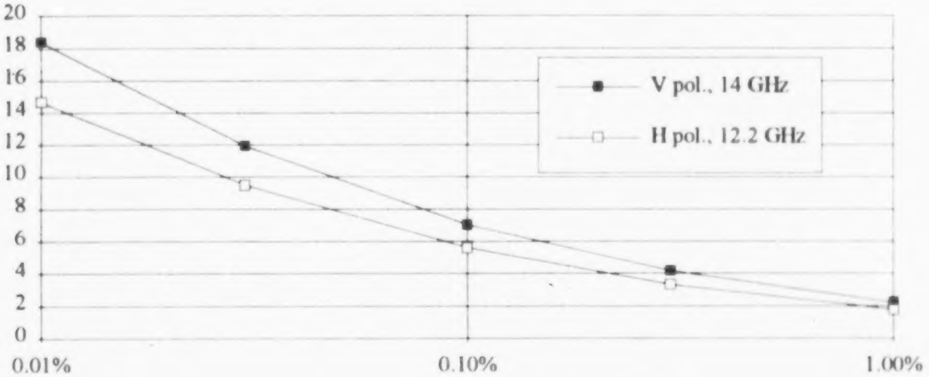
M
N
P
N
P
N
F
E
M
D
F
D

Fig. 3. Ku-band attenuation in Hong Kong



uplink station receives the source television signal in NTSC, PAL or SECAM format and digitizes, compresses, packetizes, encrypts, multiplexes, forward error-corrects, modulates, up-converts, amplifies and transmits the signal to the satellite. The IRDs will perform the inverse processing on the received downlink signal to restore the baseband analog signal. CATV networks can use IRTs to recover the baseband compressed digital video signal and re-transmit it to subscribers, using a transmission standard properly designed for cable. The whole transmission chain can be divided into three major components : Video compression, transmission and conditional access.

For years, people tried to establish standards in order to facilitate the development of digital TV and lower the price. These are now in place.

3.1 - Standard for Video compression

The MPEG-2 standard is almost universal.

3.2 - Standard for Satellite Digital TV broadcasting

There are several standards currently used for satellite digital TV broadcasting, among them, the European Digital Video Broadcasting (DVB) standard which is used extensively in the Asia-Pacific region. It is the basis for the discussion below.

For satellite transmission, the most common modulation scheme is QPSK, which tends to balance transponder bandwidth usage and power usage. However, for DTH (direct-to-home) applications, lower bandwidth efficiency schemes, such as BPSK, are sometimes required to increase the satellite downlink power efficiency (at the expense of data rate). A concatenated coding scheme is used to enhance the link robustness. The inner code is a classical punctured-convolutional code of code rate, 1/2, 2/3, 3/4, 5/6 and 7/8 with Viterbi soft-decision decoding algorithm. The outer code is a high rate shortened Reed-Solomon code (204, 188, t=8, m=8). Interleaving is used to randomize the error bursts at the output of the Viterbi decoder and improve the outer RS decoding efficiency.

There are two modes for the sharing of the transponder capacity, Multiple Channels Per Carrier (MCPC) and Single Channel Per Carrier (SCPC). With MCPC, all channels are time division multiplexed (TDM) into a single bit stream. The multiplexed signal then modulates a single carrier which is then transmitted through a transponder. This allows the transponder to operate at or near saturation and makes better use of the transponder power. It is more suitable for DTH application. In addition, the statistical feature of the time division multiplexer allows the transponder channel capacity to be dynamically allocated to each individual TV channel. Indeed, the compressed data flux is highly dependent on the instantaneous content of the programming and is therefor bursty.

With SCPC mode, each carrier carries only one channel and several carriers share one transponder. Due to the intermodulation noise created by the non-linearity of the high power amplifier, the transponder must be operated with output back-off. In general only 35% - 50% of the transponder power can be used. The advantage of this transmission mode is its flexibility, allowing TV programming to be uplinked from different sites and is more suitable for applications such as feeds and SNG (satellite news gathering) where only one channel is needed.

Digital TV, compared to conventional analog TV, exhibits some interesting features. Digital transmission systems can work at a lower signal-to-noise ratio. Smaller dishes can be used to receive the TV signals. This is particularly true for C-band systems where the typical TVRO dish size for analog TV reception is 2.0 m. While with Digital TV the size can be reduced to 1.5 m. Digital TV is therefor more suitable for DTH applications.

With digital modulation, more than 4 channels can fit in a 36-MHz transponder while only one channel can fit using analog modulation, hence a reduction of space segment cost for broadcasters. In addition, the fact that a 24-transponder satellite can transmit up to 100 TV channels makes any satellite potentially a "Hot Bird"--a satellite all of the programmers want to be on. Satellite location, coverage and power, together with programming will be the ultimate factors that determine the success of a digital TV "Hot Bird."

Due to the use of extensive use of error correction coding, the received picture quality of IRDs exhibits a "threshold effect." That is, if the signal-to-noise ratio at the IRD input is above the threshold, there will be a perfect picture--quasi error free (QEF) transmission will be achieved. Just below the threshold, the picture quality will degrade very rapidly until complete loss of picture. During system design, it is of great importance to select an appropriate system margin to guarantee minimum system availability. In other words, a well-designed system should be, to some extent, insensitive to bad weather and/or expected antenna pointing errors. Quasi error-free transmission allows a TV program to be re-transmitted many times without degrading picture quality and makes Digital TV the ideal means for long distance programming delivery.

Due to the nature of digital signals, a digital TV system can use sophisticated encryption systems and implement conditional access control for Pay-Per-View service. The packet data format makes it easy for a digital TV signal to be converted to the ATM transport format and paves the way for its integration into future B-ISDN networks.

It must be pointed out that Digital satellite TV also has some disadvantages. At this stage of development, the price of IRDs is the main obstacle, in particular for individual reception in countries like India and China. It is less a constraint for the CATV and SMATV network operators as the cost is averaged over many individual viewers.

3.3 - Conditional Access and interoperability

A conditional access system provides a mean to prevent any unauthorized viewers to receive programming and thus protect the interest of broadcasters. Conditional access systems support different payment schemes, such as subscription and pay-per-view. With digital transmission system, the implementation of the conditional access systems is made easier. A conditional access system is implemented through the use of scrambling / encryption mechanism. The scrambler is used to make the sound and picture imperceptible and the encryption system is used to protect the key for the descrambling the received signal.

Under the DVB standard, there would be no standard conditional access system but a standard interface, called the "common interface." All conditional systems will be proprietary and contained in detachable modules which communicate with the IRDs through the common interface. The set up of the common interface has a particular importance in the sense that it allows viewers to receive programming of different broadcasters with the same IRD.

Unfortunately, most of today's existing IRDs do not have this common interface. Furthermore, not all DVB/MPEG-2 compliant IRDs can be used to receive even unscrambled free-to-air transmission. Conditional access and interoperability present a challenge which must be met for the successful introduction of digital TV.

4 - Antenna size

The purpose of this section is to analyze, through application examples, the minimum required TVRO dish size for the reception of digital TV at both C-band and Ku-band and for both SCPC mode and MCPC mode. BPSK modulation is also considered.

The uplink earth station is assumed to be located in Hong Kong, which is in rain climatic zone N where the rainfall intensity exceeds 90 mm/h for 0.01% of an average year. The Uplink earth station antenna size is 7 meter and is equipped with a UPC system of 20 dB dynamic range, which means that the uplink power can be automatically increased up to 20 dB in case of rain.

DVB transmission standards and the AsiaSat-2 orbital location, 100.5°E, are used to perform the analysis. Specifically, the assumed parameters are :

Service Availability:	99.7%, 99.9% and 99.99% of an average year
Location of TVRO:	Beijing, Bombay, Kuala Lumpur
Covolutional inner code:	1/2, 2/3, 3/4, 5/6 and 7/8
Modulation:	QPSK and BPSK re-configurable with constant modulation rate of 25.776 MBaud/s.
LNB Noise figure:	1.1 dB
Frequencies:	12.2 GHz at Ku-Band and 3.7 GHz at C-Band
Polarization:	Vertical in the uplink and Horizontal in the downlink
Satellite EIRP:	51 dBW Ku-Band and 39 dBW C-Band
Transponder Bandwidth:	36 MHz
Adjacent satellites:	Homogenous satellites at 2.5 degrees spacing transmitting at saturation.

Application 1 - MCPC

Based on the above assumptions, the required TVRO dish size has been obtained through link calculation and is given in Table 1 for C-band systems and Table 2 for Ku-band systems. A 36-MHz bandwidth transponder is assumed with single carrier operation. For the Ku-band analysis, several TVRO locations in different rain zones are considered:

- Beijing, located in the rain climatic zone K with rainfall intensity exceeding 40 mm/h for 0.01% of a average year.
- Bombay, located in the rain climatic zone N with rainfall intensity exceeding 95 mm/h for 0.01% of a average year.
- Kuala Lumpur, located in the rain climatic zone P with rainfall intensity exceeding 145 mm/h for 0.01% of an average year.

The calculation has also been carried out for the MCPC mode with BPSK modulation to reduce further TVRO dish size. Results are shown in Table 3 for C-band and Table 4 for Ku-band.

In general, good C-band performance can be obtained with 2 meter antennas--slightly larger as FECs go from 1/2 to 7/8 and slightly smaller with BPSK modulation. Note that this reduced antenna size comes at the expense of reduced data rates. Ku-band performance is heavily dependent on rain rates and availability.

Telecommunications links typically have an availability of 99.99% ("four nines"). In a year of 8766 hours, there would only be 53 minutes of service outage. This is relatively trivial unless it occurs in the middle of a World Cup or Super Bowl game. An availability of 99.9% ("three nines") would mean 8 hours and 46 minutes of outage. This is probably enough to be annoying, even if the outage does not occur during a critical viewing period. Note that maintaining a 99.99% availability in Kuala Lumpur would require an antenna size of from 4 to 7 meters depending on FEC. An antenna this size is probably impractical--residents of Kuala Lumpur and other high rain areas will have to accept somewhat lower availability.

Application 2 : SCPC

Four SCPC carriers are assumed to be transmitted in one transponder with each occupying 9 MHz bandwidth. Based on the assumption, the required antenna size has been obtained through link calculation and is given in Table 5 for C-band and Table 6 for Ku-band.

Note that antenna sizes are not greatly different from the MCPC case. Among many reasons for this is that the interference from adjacent satellites is a dominant factor with small antenna sizes. Increasing antenna size not only increases the DTH signal, it also reduces the interfering signal.

Economics

Although satellite digital TV equipment is available on the market, the price is too high for individual reception in much of the Asia-Pacific. Most of the countries in the Region are still developing countries. Most residents probably have access to TV, but may not have a TV set in their home. This is rapidly changing. Already it is assumed that nearly half the households across the region have a television.

Because of cost issues, it is expected that during the initial phase of Digital TV implementation, the users will be mainly CATV and SMATV operators who will decode the signals at the headend and distribute analog PAL or NTSC to consumers. Over time, However, some cable subscribers may will switch to DTH when the price becomes affordable.

What is an affordable price? In high-income countries, a DTH antenna/IRD (or cable set-top box) cost of around US$500 is considered a critical price point. In much of the Asia-Pacific per capita incomes are 1% of OECD levels. It is unreasonable to expect the cost of these items to ever approach US$5. However, the Asia-Pacific middle class is growing rapidly, and already has incomes approaching OECD levels. The first digital TV receivers in the Asia-Pacific are large cable system operators who can afford the new digital equipment and the rich. As incomes rise and the cost of digital equipment falls, digital TV and DTH will soon become ubiquitous.

Conclusion

Satellite Digital TV is undoubtedly a technically superior solution for programming delivery in terms of picture quality, TVRO dish size, flexibility, access control, and transmission cost. It will progressively replace satellite analog TV. However, the key to its success lies in the programming itself, satellite location, and satellite coverage. Satellite digital TV will aid the expansion of DTH, but satellite digital TV will probably continue to rely on cable networks for program distribution for some time to come.

References

1. Background Document on Digital Video Broadcasting, Assembled for Members of the European DVB Project, April 1994.

Table 1. C-Band TVRO dish size for the reception of digital TV

FEC	Multiplexed Data rate (Mbit/s)	TVRO dish size (m)
1/2	23.754	2.0
2/3	31.672	2.1
3/4	35.631	2.2
5/6	39.590	2.3
7/8	41.570	2.4

Table 2(a). Ku-Band TVRO dish size for the reception of digital TV in Beijing

FEC	Multiplexed Data rate (Mbit/s)	TVRO dish size (m) for a availability of 99.70%	TVRO dish size (m) for a availability of 99.90%	TVRO dish size (m) for a availability of 99.99%
1/2	23.754	0.58	0.6	0.78
2/3	31.672	0.64	0.66	0.93
3/4	35.631	0.67	0.69	1.06
5/6	39.590	0.7	0.73	1.21
7/8	41.570	0.71	0.75	1.3

Table 2(b). Ku-Band TVRO dish size for the reception of digital TV in Bombay

FEC	Multiplexed Data rate (Mbit/s)	TVRO dish size (m) for a availability of 99.70%	TVRO dish size (m) for a availability of 99.90%	TVRO dish size (m) for a availability of 99.99%
1/2	23.754	0.62	0.68	1.89
2/3	31.672	0.67	0.77	2.33
3/4	35.631	0.71	0.83	2.64
5/6	39.590	0.75	0.92	3.01
7/8	41.570	0.77	1.01	3.27

Table 2(c). Ku-Band TVRO dish size for the reception of digital TV in Kuala Lumpur

FEC	Multiplexed Data rate (Mbit/s)	TVRO dish size (m) for a availability of 99.70%	TVRO dish size (m) for a availability of 99.90%	TVRO dish size (m) for a availability of 99.99%
1/2	23.754	0.65	0.83	4.12
2/3	31.672	0.72	1.02	5.05
3/4	35.631	0.77	1.17	5.71
5/6	39.590	0.83	1.31	6.47
7/8	41.570	0.88	1.4	6.98

Table 3. C-Band TVRO dish size for the reception of digital TV using BPSK modulation

FEC	Multiplexed Data rate (Mbit/s)	TVRO dish size (m)
1/2	11.877	1.5
2/3	15.836	1.8
3/4	17.816	1.9
5/6	19.795	2.0
7/8	20.785	2.1

Table 4(a). Ku-Band TVRO dish size for the reception of digital TV in Beijing

FEC	Multiplexed Data rate (Mbit/s)	TVRO dish size (m) for a availability of 99.70%	TVRO dish size (m) for a availability of 99.90%	TVRO dish size (m) for a availability of 99.99%
1/2	11.877	0.47	0.49	0.62
2/3	15.836	0.64	0.66	0.93
3/4	17.816	0.67	0.69	1.06
5/6	19.795	0.7	0.73	1.21
7/8	20.785	0.71	0.75	1.3

Table 4(b). Ku-Band TVRO dish size for the reception of digital TV in Bombay

FEC	Multiplexed Data rate (Mbit/s)	TVRO dish size (m) for a availability of 99.70%	TVRO dish size (m) for a availability of 99.90%	TVRO dish size (m) for a availability of 99.99%
1/2	11.877	0.5	0.56	1.32
2/3	15.836	0.67	0.77	2.33
3/4	17.816	0.71	0.83	2.64
5/6	19.795	0.75	0.92	3.01
7/8	20.785	0.77	1.01	3.27

Table 4(c). Ku-Band TVRO dish size for the reception of digital TV in Kuala Lumpur

FEC	Multiplexed Data rate (Mbit/s)	TVRO dish size (m) for a availability of 99.70%	TVRO dish size (m) for a availability of 99.90%	TVRO dish size (m) for a availability of 99.99%
1/2	11.877	0.53	0.65	2.89
2/3	15.836	0.72	1.02	5.05
3/4	17.816	0.77	1.17	5.71
5/6	19.795	0.83	1.31	6.47
7/8	20.785	0.88	1.4	6.98

Table 5. C-Band TVRO dish size for the reception of digital TV using SCPC transmission mode

FEC	Single channel Data rate (Mbit/s)	TVRO dish size (m)
1/2	5.939	2.2
2/3	7.918	2.4
3/4	8.907	2.5
5/6	9.898	2.6
7/8	10.393	2.7

Table 6(a). Ku-Band TVRO dish size for the reception of digital TV in Beijing

FEC	Single channel Data rate (Mbit/s)	TVRO dish size (m) for a availability of 99.70%	TVRO dish size (m) for a availability of 99.90%	TVRO dish size (m) for a availability of 99.99%
1/2	5.939	0.68	0.71	1.13
2/3	7.918	0.73	0.78	1.39
3/4	8.907	0.77	0.83	1.61
5/6	9.898	0.81	0.93	1.88
7/8	10.393	0.84	1.1	2.07

Table 6(b). Ku-Band TVRO dish size for the reception of digital TV in Bombay

FEC	Single channel Data rate (Mbit/s)	TVRO dish size (m) for a availability of 99.70%	TVRO dish size (m) for a availability of 99.90%	TVRO dish size (m) for a availability of 99.99%
1/2	5.939	0.73	0.87	2.8
2/3	7.918	0.8	1.12	3.56
3/4	8.907	0.87	1.27	4.15
5/6	9.898	1.06	1.44	4.9
7/8	10.393	1.18	1.6	5.47

Table 6(c). Ku-Band TVRO dish size for the reception of digital TV in Kuala Lumpur

FEC	Single channel Data rate (Mbit/s)	TVRO dish size (m) for a availability of 99.70%	TVRO dish size (m) for a availability of 99.90%	TVRO dish size (m) for a availability of 99.99%
1/2	5.939	0.8	1.23	6.04
2/3	7.918	0.96	1.52	7.56
3/4	8.907	1.15	1.75	8.7
5/6	9.898	1.3	2.02	10.09
7/8	10.393	1.4	2.22	11.08

Satellites and Global Information Infrastructures

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ABSTRACT

The paper addresses the role of Satellite communication networks in Global Information Infrastructures (GII). Substantial international cooperation - reachable via industrial cooperation among the involved World Regions - is required to exploit the huge potential for global market penetration, thus fostering the development of **"global"** economy. Thus, regulatory and geo-political aspects keep pace with technological breakthroughs necessary to physically implement and deploy the systems.

1. INTRODUCTION - THE ROLE OF SATELLITES IN GLOBAL COMMUNICATION NETWORKS

Satellite communications can effectively complement terrestrial networks wherever the latter are either not competitive (low traffic density), not applicable (maritime and aeronautical services) or less/not developed at all. For maritime and aeronautical communication services, where terminals are not strictly required to be "personal" (portable), the mature technologies of Geostationary Earth Orbit (GEO) satellite systems are probably the most suitable for present and future enhanced systems. Over the last few years, however, a worldwide interest has arisen on Personal Communication Networks/Services (PCN/PCS), where satellites can play a crucial role in a global scenario. Satellite PCS (S-PCS) - also known as (Global) Mobile Satellite Systems, (G)MSS, and "big" LEOs - refer to satellite systems, mostly in Non-GEO Orbits (NGSO), that permit telephone transmissions via wireless handsets to reach destinations anywhere on Earth [1][2].GEO satellites can also be effectively utilized for setting up S-PCS. However, for such applications, other orbital configurations (Low/Medium Earth Orbit (LEO/MEO) constellations) are being considered as more effective for the provision of PCS to hand-held terminals. Differently from GEO satellites, LEO spacecraft only fly across the service area for some tens of minutes a few times a day (depending upon the orbital parameters), so that a real-time service is not allowed unless a complete constellation of LEOs (from about 10 to as many as several hundred) is operational, in such a way to have at least one satellite in visibility for 100 % of the time [3]. Conversely, the lower altitude (typically from 700 km upwards as opposed to 36,000 km GEO) permits more effective communication performances with smaller/less complex user terminals, due to substantially lower link attenuation (15-to-20 dB depending upon the orbit).

Hence, a huge potential exists for satellite/wireless communications in Global Information Infrastructures. It is neither realistic nor cost-effective to envisage, even in the long run, developing countries - as well as developed countries to some extent, wherever sparsely populated, wide areas exist - being equipped with wireline technologies across the whole territory. Rather, they will likely have important nodes of the Country connected via wireline/satellite links, whereas wireless/cellular "leopard" spots will cover (part or the whole of) the remaining areas. In these areas, Wireless Local Loops (WLL) are also aggressively emerging as a low-cost solution to the *last mile* problem. Those areas include nowadays more than 3 billion individuals, who will become 5 billions by the turn of the century. The only reasonable way to penetrate this market is to exploit wireline **and** satellite/wireless technologies **together**. In this respect, if the satellite fraction of telecommunication revenues is commonly estimated less than 3 % of the market, in global infrastructures this percentage may likely reach 5-10 %. Associated to wireless technologies, satellite communications may play a major role in global communication infrastructures.

2. "TECHNICAL"/"GEO-POLITICAL" ISSUES WITH GLOBAL SATELLITE NETWORKS (GSN)

- **By-Pass / National Sovereignty.** National

Administrations are concerned that GSN will drain calls (i.e. revenues) from their national networks. They also tend to keep close control over new systems, since often satellite footprints wander into unauthorized transmission areas, another perceived threat to national sovereignty.

- **Market Access.** Developing countries are concerned that the bulk of their citizens may not be able to afford GSN.
- **Safety and Distress Operations.** GSN should be an essential element in disaster relief.
- **Call Monitoring.** Currently, nations generally can monitor or intercept telephone transmissions within their countries. A major concern that national regulators have is whether GSN can allow law enforcement personnel to continue to monitor calls.
- **Country Code.** One aspect of sovereignty that GSN operators are trying to achieve is each system having its own country code, so in essence each GSN would be a "virtual country".
- **Equipment Type Approval, Free Circulation and Use.** In Europe, the Mutual Recognition Directives will facilitate free circulation of GSN handheld terminals. and a CEPT decision would extend type approval outside the Union. The eighteen member Asia-Pacific Economic Cooperation (APEC) and the thirty-five member Inter-American Telecommunications Commission (CITEL) are also moving towards mutual recognition of equipment, as well as free circulation and use of equipment.
- **Interworking with Terrestrial Systems.** Very useful not only for bypass concerns, but also for seamless interconnection/roaming with terrestrial wireless systems, facilitating type approval of GSN terminals through already established framework (e.g.GSM MoU).
- **Network Management Issues.** Adopting the ISO/ITU *TMN* (Telecommunication Management Network) terminology, the management functions relevant to a GSN can be split among three main Operation Systems Functions (OSF) for (i) Network Management (monitoring and control of network links, resource management, performance monitoring, billing management,...), (ii) Element Management (EM) for the space segment (monitoring and control of spacecraft) and (iii) EM for the ground segment (monitoring and control of the Gateway Earth Stations and related subsystems). In addition, appropriate Data Communication Functions allow the exchange of management information among OSF and between OSF and managed Network Elements.
- **Management of Routing Information.** In S-PCS, the information identifying the GSN subscribers are distributed among the Gateways. Each Gateway will use two registers to store these data: the first one (corresponding to the Home Location Register - HLR - of GSM) contains the data of the subscribers belonging to its "territory", whereas the second one (corresponding to the Visitor Location Register - VLR - of GSM) contains the information necessary to validate and route calls to all subscribers roaming in its region. The information of roamers are temporarily stored for the whole duration of the subscribers stay in that region.
- **Business Support System.** The service provision requires a dedicated software structure commonly referred to as Operation (or Business) Support System (OSS/ BSS). It takes care of such important aspects as **billing** and **settlement** policies, including the definition of traffic revenue sharing among Network Operators, Regional Operators and Service Providers -- the latter representing the "one-stop-shopping" customer interface (subscription, billing, customer care, ...).

3. PRESENT STATUS OF GLOBAL SATELLITE SYSTEMS, FORERUNNERS OF THE GLOBAL INFORMATION INFRASTRUCTURE

3.1. BIG LEOs (TABLE 1).

Globalstar. Globalstar announced investors include Loral Corporation, Space Systems Loral, Qualcomm and AirTouch in USA, TESAM (a joint venture between France Telecom and Alcatel), Alenia Spazio and Finmeccanica (Italy), Deutsche Aerospace, Hyundai and DACOM in South Korea and Vodafone in UK. Total equity commitment amounts to $294M (reaching $1.040B including external financing) out of an estimated $2.5B system cost to construct and launch the Globalstar Satellite System **by 1999**.

Inmarsat. On January 24, 1995, Inmarsat announced the establishment of an Affiliate ("ICO Global

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Communications") for managing S-PCS, that received investment commitments for $1.493B (out of an estimated $2.6-2.9B system cost) from 39 Investors around the World, comprised of Inmarsat itself and Inmarsat Signatories and/or their subsidiaries (most of them from Asia). Start of Service: **2000.**

Iridium. Investors - in addition to Motorola - include Sprint, Lockheed-Martin and Raytheon in the USA, Bell Canada, DDI (Japan), UCOM (Thailand), KMT (Korea), Krunichev (Russia), China Great Wall Industries, Pacific Electric Wires Co. (Taiwan), Saudi, Indian and South American Investors; in Europe, Iridium is backed by Italy's STET and German VEBA. The Iridium European Consortium also include industrial activities, performed by Siemens (D900 Gateway Switch) and STET's ***Nuova Telespazio*** (System Control Segment, System Engineering, Telecommunication Management Networks (TMN), Gateway Engineering, Installation and Operation, Business Support System, ...). Furthermore, ***Nuova Telespazio*** is setting up, in cooperation with Motorola, the $1B network of Ka-band Gateway Stations for interconnection to PSTN. In January 1996, Iridium has announced commitments from Investors totaling $1.9 B (out of $3.37B system cost). The start of service (FOC, Fully Operational Capabilities) is due in the **third quarter of 1998**.

Odyssey. Odyssey has raised a total of $180M (out of $2.5B), $120M from TRW (USA) and $60M from Teleglobe Canada. No other Investors have been announced.

3.2. KA-BAND SATELLITE SYSTEM PROPOSALS (TABLES 2 AND 3 [4][5][6])

(Start of Service: 1999-2002)

M-Star. FCC filing (September 4, 1996) requesting 1.5 GHz spectrum at 40/50 GHz. Bent-pipe repeater, ensuring global coverage (via intersatellite links) for wireless backhaul, corporate private users/ Intranet links, LANs, WANs,... 12 LEO orbital plans (47° inclination), 6 satellites/plan, for a total of 72 Satellites at 1350 km altitude. 22° minimum ground elevation required.

Sativod. Ku (11/14 GHz) - Ka (20/30 GHz) band system proposed by Alcatel, featuring 32-64 spacecraft LEO constellation at 1626 km for broadband communications to/from low cost ($ 750), small terminals (35 cm dish). Gateway (GW) stations are needed every 200-500 km to ensure global PSTN interconnection, at an overall system cost of $2.7 B.

Teledesic. 840-spacecraft (plus 84 spare), 21 orbit LEO constellation (700 km altitude, US$9B estimated cost) to provide (fixed and mobile) services to countries/regions lacking of telecommunication infrastructures [4].

Astrolink. Five GEO satellites ($2.4B cost), interconnected through intersatellite links, to provide digital communications services including voice, data, and video, with data rates from 384 kbps to 8.448 Mbps.

Cyberstar. Three GEO satellites ($1.050B), interconnected through intersatellite links, to provide video, videoconferencing and tele-imaging to commercial and residential users, via low cost home terminals.

Echostar. Two GEO satellites ($340M) to provide a wide range of video, audio and data services at transmission rates from 384 kbps to 1.544 Mbps.

Galaxy/Spaceway. Nine GEO satellites, interconnected through intersatellite links, operating in both Ka and Ku-bands. The $3.2B system would provide worldwide video distribution, as well as audio and data communications on a direct-to-home basis utilizing a 26" (66 cm) antenna [5].

GE Star. Nine GEO satellites to offer video, audio, teleconferencing to small ground stations, at data rates ranging from 384 Kbps to 40 Mbps.

Millennium. Four GEO satellites ($2.3B), interconnected through intersatellite links, to offer a variety of point-to-point and multi-point communications on a real time basis, including voice, fax, video and data services at speeds up to 51.84 Mbps.

Morningstar. Four GEO satellites ($936M) to provide high speed voice and data communications as well as on demand entertainment programming to small satellite dishes.

Netsat 28. One GEO satellite ($250M) with fully interactive 1.544 Mbps service.

Orion. Six GEO satellites($1.6B) to support high speed digital services via 155 Mbps transponders.

PAS 9. Two GEO satellites ($409M) providing video, audio and data communications.

VisionStar. One GEO satellite ($207M) to provide interactive video distribution services.

Voicespan. Twelve GEO satellites to provide a variety of communications services ranging from basic telephony to advanced multimedia offerings, with data rates ranging from 32 Kbps to 1.544 Mbps.

4. CONCLUSIONS

Some critical system/service aspects related to the deployment of GII have been addressed. Significant issues concern equipment standardization and type approval, frequency spectrum allocation and assignment (i.e. licensing), mutual recognition of licenses, multiple-entry provision and so forth. Thus, in addition to ***technological*** challenges, ***service, market*** and ***regulatory aspects*** are indeed ***key issues*** to consider when designing, physically implementing and deploying the GSN systems [7]. Additional issues to be addressed when designing and deploying Global Information Infrastructures include Interworking with different networks (GII basically are *networks of networks*, providing voice, data, image, multimedia), Network Management & Intelligent Networks, Business Support Systems for Billing & Administration of Traffic, Numbering Plan, Gateway Earth Stations Implementation and Interconnection with the Public Switched Telephone Network (PSTN), Network Planning and Deployment, Service Distribution, and so forth.

As a final remark, key *technology* initiatives to get toward the GII include global (wireline/wireless) networks, highly survivable SDH (SONET)-based networks, acceptance of ATM internationally, integrated service management,... Key *business* initiatives concern applications engineering and integrated solutions, strategic technology/equity partnerships, global mergers and acquisitions, purchase of wireless/satellite spectrum,... Such initiatives concur with the need for ***creating synergies, rather than competition, among satellite, wireless and wireline technologies***, to pave the road for the deployment of Global Information Infrastructures.

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TABLE 1. “BIG” LEO SYSTEMS.

SYSTEM	ORBIT ALTITUDE (km)	INCLI-NATION	PERIOD (minutes)	ORBITAL PLANES	SAT's/ PLANE	TOTAL # OF SAT's
ARIES	Circular (1018)	90°	105.5	4	12	48
TELEDESIC	Circular (700)	98.2°	98.77	21	40	840
ELLIPSO BOREALIS	Elliptic (520/7800)	116.5°	180	3	5	15
ELLIPSO CONCORDIA	Circular (7800)	0°	280	1	9	9
GLOBALSTAR	Circular (1389)	47°52°	113.53	8/8	3/6	24/48
INMARSAT	Circular (10500)	55°	360	3	4	12
ODYSSEY	Circular (10373)	55°	359.53	3	4	12
IRIDIUM	Circular (780)	86.4°	100.13	6	11	66

SYSTEM	FREQUENCY		SERVICE		COST (US $ M)
	User Link	Feeder Link	Voice (kbps)	Data (kbps)	
ARIES	L/S	C	4.8	2.4	<500
TELEDESIC	Ka	Ka	4.8	16-2048	9,000
ELLIPSO	L/S/C	L/S/C	4.8	0.3-9.6	600
GLOBALSTAR	L/S (up/downlink)	C	2.4, 4.8, 9.6	9.6	2,500 (48 satellites)
INMARSAT	S	C or Ku	2.4, 4.8	2.4	2,900 (12 satellites)
ODYSSEY	L/S	Ka	4.8	9.6	2,500 (12 satellites)
IRIDIUM	L	Ka	2.4, 4.8	2.4	3,370

TABLE 2. PROPOSED BROADBAND LEO SATELLITE SYSTEMS.

SYSTEM	COST	# SATs	FREQUENCY	USER DATA RATE	USER DISH SIZE
M-Star (Motorola)	$6.15B	72	40/50 GHz	2.048-51.84 Mbps	66-150 c m (26"-59")
Sativod (Alcatel)	$2.7B	32-64	11/14 GHz (users) 20/30 GHz (GW)	16-2048 kbps (return link) < 60 Mbps (forward link)	<40 cm (<16")
Teledesic	$9B	840	20/30 GHz	16 kbps-2.048 Mbps	30-150 cm (12"-59")

TOTAL NUMBER OF LEO SATELLITES: 972
TOTAL ESTIMATED COST: $17.85B

TABLE 3. PROPOSED BROADBAND GEO SATELLITE SYSTEMS (20/30 GHz).

SYSTEM	COST	# OF SAT's	USER DATA RATE	USER DISH SIZE
Alenia Spazio EuroSkyWay	$500M (1st phase)	2 (1st phase) 5 (2nd phase)	144-2048 kbps (uplink) 32.768 Mbps (down/l)	45-60 cm (18"-24")
AT&T VoiceSpan	$3.2 B	12	32 kbps-1.544 Mbps	N/A
CellularVision VisionStar	$207 M	1	N/A	N/A
EchoStar	$340 M	2	384 kbps-1.544 Mbps	N/A
GE Americom GE*Star	$4 B	9	384 kbps-40 Mbps	66 cm (26")
Hughes Galaxy/Spaceway	$3.2 B	9	384 kbps-6 Mbps	66 cm (26")
KaStar Ladybug	$370 M	2	384 kbps	60 cm (23.5")
Lockheed Martin AstroLink	$2.4 B	5	384 kbps-8.448 Mbps	66-120 cm (26"-47")
Loral (LAHI) CyberStar	$1.05 B	3	384 kbps-3.088 Mbps	70 cm (27.5")
Morning Star	$936 M	4	N/A	N/A
Motorola Millennium	$2.34 B	4	384 kbps-51.84 Mbps	70 cm (27.5")
Netsat 28	$250 M	1	384 kbps-1.544 Mbps	30 cm (12")
Orion	$1.6 B	8	64 kbps-2.048 Mbps	1.8-2.4 m (71"-94.5")
PanAmSat	$1.8 B	9	N/A	N/A

TOTAL NUMBER OF GEO SATELLITES: 70
TOTAL ESTIMATED COST: $21.7B

(N/A = Not Available)

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In 1987 he was appointed Associate Professor of Digital Signal Processing at the University of Rome-Tor Vergata, Electronics Engineering Dept.

In 1990 he has joined again TELESPAZIO (renamed "*NUOVA TELESPAZIO*" in January 1995), where he has held a number of positions, including Director of Marketing and Vice President/Director of the Advanced Studies and Experimentation Division.

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He has performed a number of studies for National and International Organizations, including ESA, EUTELSAT, INMARSAT and INTELSAT, is author of a Radio Systems book, Chapters of the "Satellite Communication Systems Design" book ("Digital Transmission Channel") by Plenum Publishing (1993) and "*The Froehlich/Kent* Encyclopedia of Telecommunications" ("Mobile Satellite Systems in Europe"), Vol.11, by Marcel Dekker, Inc. (1995), and over 110 papers on Planning and Design of Communication Systems and related Technologies.

Issues in Convergence: Should Telcos Be Subject to Cross-Media Ownership Restrictions?

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Cross-media restrictions have a clear social policy objective: to ensure diversity of ownership so that information flows to the public are not restricted or distorted by those who control the carriage of the information. This paper examines the relevance of the policy objective and the rules in a converging world promising multiple providers of information.

Introduction

Nobody needs to be reminded that the convergence of technology and services has blurred industry boundaries of telecommunications and broadcasting.

Convergence raises many regulatory issues, which have seen much debate in the forum of the PTC over the last few years. Not the least of these issues is the status of specific regulatory rules which aimed to achieve industry-specific policy objectives.

The specific regulatory rules on which this paper will focus are traditionally broadcasting-specific - the 'cross-media' rules: those rules which put restrictions on the ownership or control of media outlet. The paper will look at the status of cross-media rules in the converging communications world: are the rules irrelevant or are they no longer broadcasting-specific?

The essential question is whether the policy objective for which the rules existing in broadcasting regulation has dissipated in the converging environment, or whether the objective remains and demands wider application of the rules (or variants) in a converging world. The current Australian debate about the status of Australia's cross-media restrictions is the contextual background for the paper.

The rationale for cross-media restrictions

Governments have for many years been concerned about the potential for the media industry to be dominated by a single entity, the 'media baron'. Why is the media any different to other industries where concerns about concentrated ownership exist and are met in most developed countries by anti-trust controls on anti-competitive mergers?

The reason is that dominant control of the media is not just a competitive or economic issue, but has inherent undesirable social consequences. Fundamentally, the danger is that ***those who control the carriage of the content could inhibit the creation of content*** with the consequence that the flow of information to the public, both in terms of which information is made available and how it is presented, may be restricted or distorted.

Diversity of ownership and control of the media is therefore an objective to be pursued for social policy ends.

One way of ensuring diversity in media ownership is to impose restrictions on owning or controlling significant proportions of more than one type of media outlet - that is, cross-media ownership restrictions. There are variations, but the usual type of restriction is that an entity which owns or controls a TV or radio commercial broadcasting station within a particular licence area is prohibited from owning or controlling a newspaper within the same area. The figure which triggers the ownership/control prohibition is generally around 15%.

Cross-media restrictions do have disadvantages. They are a rather blunt way of dealing with the issue and show signs of being dated - most do not apply beyond free-to-air broadcasters and do not include cable and satellite broadcasters. By being specific about the type of broadcasting within the rules they run counter to the current regulatory 'technology-neutral' philosophy. But more particularly, the acceptable levels of ownership/control, the types of media to which they apply, and the geographic area they cover, are clearly susceptible to political lobbying.

But notwithstanding the disadvantages, the social policy underscoring them is clear and the objective they aim to achieve is clear.

The relevance of cross-media rules in a converging communications world

There is no doubt that the cross-media rules as they exist in most broadcasting regulatory frameworks are dated. As already noted, most do not apply to cable and satellite broadcasting. Of even more significance are the following:

- the developing role of telecommunications carriers in the business of providing information and entertainment, evidenced particularly by the alliances between carriers and content providers for the delivery of Internet services and on-line services over the network infrastructure owned or operated by the carrier e.g. the alliances between BT and News Corporation Ltd, between Telstra and News Corporation Ltd and between Optus and free-to-air broadcasters;
- the increasing capacity for the provision of news, information and entertainment by non-traditional media. For example, the virtually unlimited capacity for multiple channels on cable networks, the rapid expansion of the Internet, the proliferation of PCs in the home - theoretically, the average consumer could be bombarded by news, information and entertainment, complementary and competitive with existing media such as newspapers, packaged by a content provider of choice, delivered to the home or office via the consumer's choice of delivery means to the consumer's choice of terminal equipment (be it TV or PC).

These significant developments raise fundamental questions in respect of the traditional cross-media restrictions which can almost simplistically be distilled to two competing propositions: abandonment or extension?

The 'abandonment' proposition is based on the view that the unlimited capacity and multiple providers make the rules irrelevant, because in such an environment, dominance is not possible.

The 'extension' proposition derives from the view that the increased role of non-free-to-air broadcasters in the delivery of news, information and entertainment means that those new carriers, be they satellite, cable or telecommunications companies, should also be brought within the net of rules designed for the traditional media.

In between, are various nuances including variation (e.g. higher/lower levels) and substitution (e.g. with general competition laws).

Resolution of the competing positions will, in my view, depend upon whether the social policy objective which the cross-media restrictions aim to achieve is, for whatever reason, no longer relevant.

For illustrative purposes, the paper will look at developments in Australia.

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Cross-media restrictions in Australia

The *Broadcasting Services Act* 1992 ('BSA') prohibits a person from exercising control of a commercial television broadcasting licence and a newspaper that is associated with the licence area of that licence. Thus, the BSA focusses on 'control' rather than ownership - a person with company interests exceeding 15% is taken to be in a position to exercise control of that company - and does not apply to all media but only to commercial broadcasting and newspapers.

The new Coalition Government which was elected in March 1996 foreshadowed before its election that it favoured moving from these controls to greater reliance on the competition provisions contained in the *Trade Practices Act* 1974 (i.e. a prohibition on mergers or acquisitions that would substantially lessen competition in a market). Following the election, the Minister for Communications announced that he would be setting up a three-person media inquiry and among the crucial questions to be considered in the inquiry would be the impact of new technologies and the changing ways people obtained information from the media.

The Minister also said:

'A lot of young people don't read the papers any more but get a lot of their information from on-line services. That's a pretty important part of life as far as diversity is concerned. So, should you bring that into the fold or should you look at whether the current arrangements are as effective as they might have been? Telecommunications companies are going to be vehicles for a lot of new information services.'

Months passed, and the three-person inquiry failed to materialise. It would seem the Government had difficulty persuading any nominees to head or join what would have to have been a political hot potato (for reasons explained later) and of limited prospect for c.v. and long-term career utility.

The Government abandoned the inquiry idea. Instead, it announced a 'review' of cross-media rules. An Issues Paper was released in October 1996, and submissions in response to the Paper were called for, with the stated intention of drawing up legislation in 1997. The object of the review is stated to be consideration of 'the appropriateness of the current rules in meeting the Government's stated policy objectives of plurality, diversity and competition.'

At this point, it is important to make some observations about the political context in which cross-media rules debates in Australia are generally conducted:

- that existing rules are generally considered to be discussion starting points, at least by prominent media barons, and have been known to give way under pressure.
- for truly emotive value in the debate, throw in foreign ownership levels. Currently, a single foreign direct investment in a national or metropolitan newspaper is limited to 25%. Prominent Australia media barons point out that it is unfair that a foreigner, such as the Canadian media magnate Conrad Black, are permitted to own 25% of the pre-eminent formerly-100%-owned Australian newspaper publisher John Fairfax & Co, while other true blue Australians such as Kerry Packer are only allowed to own 15% of the very same publisher (because ownership of Channel 9 triggers the cross-media restriction);
- John Fairfax & Co features prominently in cross-media rule debates, it being widely viewed as the sought-after prize of the media barons. As it currently stands, Conrad Black owns 25%, Kerry Packer owns 15% and is restricted by the rules from owning more, Rupert Murdoch owns 5%. Because overall foreign ownership in Fairfax is capped at 30%, Rupert Murdoch, who is deemed a foreigner, would need Government approval to go further, but in any event would be unlikely to succeed in any acquisition because it already controls about 2/3rds of the Australian newspaper market (although New Corp put out some feelers earlier this year about increasing its share).

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These observations apply to the current review. Clearly, any relaxation of the current rules will trigger a run on Fairfax, with a potential winner being Kerry Packer. It is for this reason that I said earlier that involvement in the proposed three-person inquiry would be a political hot-potato.

At the time of writing, submissions to the review have closed. The press has released details of the major points of submissions, and the positions taken are, of course, predictable. The review is aimed at cross-media restrictions, with the Government attempting to confine it to that without linking the foreign ownership issue. But it has kept on sneaking into the submissions.

The purpose of this paper is not to address the issue from the perspective of what will happen to Fairfax, but to concentrate on whether there is justification in the current state of Australia's communications industry for abandoning or extending the rules. It is unfortunate that the political realities of the debate in Australia have resulted in a very narrow focus being adopted to date, so that the broader issues raised of 'the implications of the emergence of new communications technologies and services' are given 'hype-service' and not fully examined.

The media barons and the telcos in Australia

Of more significance for this paper is the 'marriage' of the media barons with the telecommunications carriers in Australia.

By way of background, Australia does not have a separate cable TV industry. The provision of subscription television programmes (Pay TV) by cable is a new development in Australia, with the roll-out of rival cable networks having commenced only in 1995. It was originally intended that subscription television would be predominantly delivered by satellite, but the commercial plans of the carriers dictated the cable cours. The cable networks currently being rolled out will deliver not only subscription television (called Pay TV) but on-line services and telephony.

The history of Pay TV to date is not one of policy glory. The network roll-out itself itself continues to be an ongoing Governmental headache. There are 2 rival cable consortia, Foxtel and Optus Vision. Optus Vision is stringing its cables from the electricity poles, and has met opposition and litigation from local Council. Foxtel was going underground but has recently adopted the far-cheaper option of the power poles, again to community outrage. In the face of increasing constitutents' lobbying against the overhead rollout, Government backbenchers pressured the relevant Minister to curb the carriers' overriding powers in respect of access to land. The Minister bowed to the backbenchers' pressure and required the carriers to comply with local planning lawsm which means negotiating with the largely-hostile local councils for overhead cables. The carriers of course are unhappy about this, and the increased costs and delay entailed in the rollout.

The composition of the two cable consortia are the focus for this paper. Optus Vision is a joint venture between:

- Optus Communications (Australia's 2nd telecommunications carrier);
- Continental Cablevision Incorporation (the third largest cable TV operator in the US);
- Nine Network Australia (free-to-air TV stations wholly owned by Kerry Packer's Publishing and Broadcasting Ltd);and
- Channel 7 (14.9% owned by New Corp).

Foxtel is a consortium comprising:

- Telstra (former monopoly telecommunications carrier);
- News Limited (read Rupert Murdoch);and
- Australis (only satellite pay TV operator).

At the time of the announcement of the formation of Foxtel, it was described as Australia's dominant telecommunications carrier marrying one of the world's major content providers.

Of relevance to the debate about cross-media restrictions:

- the network infrastructure is owned and operated by the carriers, Optus and Telstra;
- the previous Government, while committed to equal access to telecommunications infrastructure, nevertheless saw fit in 1995 to declare that while the networks had to provide open access for and to the telephony and broadband services provided over the networks, they did not have to give access for pay TV services until at least 1999;
- the business partners of the carriers are the dominant media interests which would be bound by cross-media ownership restrictions (and, in Murdoch's case, foreign ownership restrictions).

In other words, the combination of telco and dominant content provider clearly has the potential to do what the cross-media restrictions aim to prevent, namely, ***that those who control the carriage could inhibit the creation of content.***

The case for abandonment of cross-media restrictions

The proponents of abandonment of cross-media ownership restrictions argue that such restrictions are a dinosaur in an era where traditional media - printed newspapers, free to air television - is rapidly being replaced by new delivery systems and new media. They argue that the explosion of on-line services and the growth of the Internet, the virtually unlimited capacity for multiple channels and the host of broadband interactive services which will be available, challenge the regulatory premise on which cross-media rules are based. The argument essentially is that there is no need to regulate ownership of the means of delivery of media to ensure diversity/avoid concentration in an era of a multiplicity of delivery systems. The very existence of a multiplicity of delivery systems would deliver diversity.

Any regulation which would be required would be provided by the competition rules prohibiting anti-competitive mergers and rules governing access to infrastructure facilities (in Australia, the competition legislation, the *Trade Practices Act* 1974, contains a detailed regime for third party access to infrastructure facilities).

The case for extension of the cross-media restrictions to telcos

There are a number of difficulties with 'abandonment' proposition.

First, it is premature. The cable networks of Foxtel and Optus Vision are still being rolled-out and there is certainly not yet a profusion of cable channels available. The Internet is still largely used for e-mail and research purposes and on-line services do not replace newspapers (although the Minister for Communications and the Arts seemed to imply that this was the case). Australia's Broadband Services Expert Group, in its report released in 1995, estimated that it would be 10 years before Australia's interactive broadband network promise would be realised. To argue for dismantling the cross-media rules in the current environment is to ignore the reality that the 'traditional media' still dominate.

Secondly, competition law is economic regulation. Athough other 'social' objectives may be achieved as a result, the primary objective of competition law is economic. A competitive market which satisfies the economic objective, or a market situation which does not breach the competition laws, may not necessarily be satisfactory context. The TPA regulates mergers because concentration of ownership is not considered to be economically good - increased market power gives control over price and output and the consumer ultimately suffers. The evil of concentration of ownership on which the cross-media rules are premised is not an economic one. It is about information flows and ensuring that a diversity of information is available to the public. Essentially, cross-media rules exist because of an acceptance of the truth, or a degree of truth, of the adage 'Information is Power'. A market outcome which meets the economic objective does not necessarily guarantee that the outcome will be the best or most desirable from a social policy perspective.

Thirdly, the concept of 'access' has wider implications in the context of broadcasting and if access rules are to be the replacement for cross-media rules, then much greater consideration and debate needs to be given to what is meant by 'open access' in this context.

The issues go beyond the economic interests which are the focus of the Australian access regime, and include:

- is the intention to confer a statutory third party right to access to all who seek a voice?
- do or should the same rights apply to all forms of media, or should special rules apply, for example, to cable (that is, because there are so many channels available)?
- do the same rights apply to public channels as to privately-owned channels?
- is the access right a group right (e.g. social, religious, political groups) or an individual right?
- who is to make the decision about which group or individual is given access and the terms and conditions of that access, including the length of time and a right of reply
- are controls over richer and more powerful groups necessary - e.g. to prevent the purchase of air-time at the expense of other rival groups
- where would the rights be enforced?

There is, additionally, a significant reason why cross-media restrictions should be extended to telcos. The philosophy underlying the restrictions is to prevent the owners of the means of delivery of information from inhibiting the availability of information to the public, either by exercising control over what was created or exercising control over what was publicly aired. Now that telcos are the owners of the means of delivery of information to the public, and that their business plans depart from the core business of telecommunications services into multimedia and online services, there seems no logical reason to leave telcos immune from cross-media restrictions.

In addition, with competition in telecommunications and the increasing rate of corporatisation and privatisation of telcos around the world, telcos now have corporate agendas to pursue in a competitive environment.

The issues are complex, and there is a need for focussed consideration and debate before competition rules and access regimes are a viable and effective replacement for cross-media rules. The Chairman of the ACCC has recognised this in his suggestion that, among other things, the Trade Practices Act apply but the cross-media laws be replaced with a media section, requiring media mergers to be notified in advance to the ACCC, to be judged on public interest and media diversity groups.

CONCLUSION

Cross-media rules aim to preserve the diversity of information presented to the public. They aim to ensure that the owners of the means of conveying the information cannot inhibit the creation and presentation of that information. Hand in hand with the converging world of technology and an emerging world of multiple providers of information is the increasing involvement of telcos in both the carriage and content-creation of information. That the telcos own and control the infrastructure which is at the heart of the converging, emerging world is a compelling reason for ensuring that they come within the entities subject to cross-media restrictions. As the industry currently stands, it seems the debate should not be about abandoning cross-media restrictions, but on consistent regulation of all entities with the capacity to control/manipulate/distort the information created and presented to the public.

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New Opportunities and Challenges When Regulators Change Course

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Abstract

The Old World Order in telecommunications featured a stable and predictable regulatory regime that classified carriers primarily on the basis of one criterion: whether the carrier provided basic and essential services to the public at large. In the New World Order a potpourri of regulatory classifications run the gamut from the traditional common carrier classification to essentially an unregulated status.

This paper will consider the migration to the New World Order with an eye toward providing carriers and users a framework for understanding what matters in a deregulated environment, or one with ambiguous regulatory classifications and service requirements. The paper will examine Internet telephony and the interconnection demands of new operators like Competitive Local Exchange Carriers and resellers in an environment where traditional common carrier rights and responsibilities do not exist. The paper concludes that while technologies like Internet telephony may help nations achieve visions of a Global Information Infrastructure, the common carrier designation remains an essential vehicle to structure the industry and ensure necessary connectivity between networks.

Introduction

Most nations throughout the world have recognized the need for their telecommunications and information processing companies to adapt to an increasingly volatile, competitive and price sensitive environment. Visions of a Global Information Infrastructure [1] contemplate seamless connectivity between networks to serve increasingly robust and diverse user requirements. Developing such a "network of networks" requires common technical standards so that different facilities may nevertheless interconnect. But equally important, it requires different types of service providers to find ways to interconnect facilities, share line management, billing and call detail information and possibly to divide toll revenues.

The need for expanded cooperation among competitors will require government oversight, particularly if nations persist in requiring carriers to pursue unprofitable universal service obligations. Many nations have embraced marketplace solutions and deregulation at the very same time as they expand the definition of, and goals for universal service. This paper concludes that if nations are to achieve the GII vision and come closer to achieving universal service goals, nations still will have to enforce common carrier obligations on many types of carriers.

The Old World Order

In the Old World Order coordination between different operators occurred easily. Carrier correspondents matched half circuits, negotiated accounting rates and toll revenue settlements [2] and achieved general consensus on technical and operational issues under the auspices of the International Telecommunication Union. [3] While differences did exist between such operators, relatively straightforward dichotomies existed so that most operators fell within a few classifications. Carriers, regulators and users generally understood these classifications, despite some differences between nations.

Historically providers of neutral and transparent conduits to the public at large operated as common carriers, or under a similar designation like the Type I carrier classification in Japan. [4] Typically these operators provided a transport function without regard to the content carried. They filed publicly available tariffs and services deemed so essential by regulators that such operators could not refuse access [5] to their bottleneck [6] facilities on the basis of content, [7] administrative inconvenience or cost.

On the other hand non-common carriers could operate as private (Type-II) carriers when providing non-essential, value adding or supplemental services. Typically these operators qualified for significantly less burdensome regulatory oversight regardless of whether they used spectrum, e.g., satellite operators, [8] or a closed circuit medium, e.g., cable television operators. [9] Their regulatory status derived from the manner in which they carried content and to whom such carriage services were made available. They did not operate essential facilities nor did they serve as gatekeepers who could affect the price and availability of the services they offered.

The New World Order

In the New World Order a variety of new regulatory classifications have appeared making it impossible to rely only on one private/common carrier dichotomy. [10] The regulatory poles now range from the common carrier classification, perhaps streamlined by reducing some of the conventional duties, to virtually unregulated status. Between these two poles lie many classifications with different rights and responsibilities affecting, for example, the duty to file tariffs, the scope of permissible services and the extent to which such services include access to the Public Switched Telephone Network ("PSTN").

The dichotomy between common carriers and private carriers has grown murky, because of:

- Legislative and regulatory tinkering with the common carrier model, primarily to foster a level competitive playing field by reducing burdens ostensibly due to changed circumstances; [11]
- Technological innovations that make it possible for private carriers to offer services competitive with what common carriers offer, including ones that access the PSTN, whether officially permissible or not; and

- A change in regulatory philosophy leading to a greater willingness to allow marketplace conditions to establish service terms and conditions even if they result in a wider range of prices, and confusion over the service commitment of carriers and the permissible scope of regulation.

While substantial reasons exist for finetuning and liberalizing common carrier burdens, few commentators [12] or policymakers believe that marketplace development to date support complete abandonment of the common carrier classification. [13] For example, the recently enacted Telecommunications Act of 1996, [14] which overhauls United States telecommunications law to support open entry and robust competition, creates an explicit assumption that telecommunication service providers will operate as common carriers. [15] However, this legislation further obscures the meaning of common carriage by authorizing the Federal Communications Commission ("FCC") to abandon any regulatory requirement, like the duty to file tariffs, if it determines that such oversight is unnecessary to ensure just and reasonable rates, consumer protection and service in the public interest. [16]

Whither Common Carriage?

Technological innovations, like the use of the Internet to provide real time voice communications present new justifications for even greater liberalization of common carrier regulation so that incumbents can fully compete with more nimble, and often unregulated, newcomers. But at the very time that incumbents demand and receive relief from some or all of their common carrier duties, the proliferation of carriers and regulatory classifications makes it more essential that incumbents make available their facilities on fair and cost-based terms, particularly when interconnecting facilities with newcomers.

At a time when network, carrier and service options proliferate the common carrier classification should stand as a foundation for how operators do business, at least for all operators who provide basic services. Such a conclusion may appear old fashioned or naive to observers who believe that the proliferation of networks, carriers and services by definition means that fundamental ground rules are no longer required, because marketplace solutions can naturally evolve. However, a single classification provides a baseline level of expectations and requirements that regulators selectively can waive as competition and marketplace self-regulation evolves.

The View That Common Carriage Has Become Obsolete

Common carriers have legitimate business reasons for seeking regulatory relief, including new opportunities to pursue non-common carrier markets. Having been regulated as a common carrier for one line of business does not preclude an enterprise from pursuing ventures outside the scope of common carrier regulation. Likewise having assumed burdensome common carrier responsibilities does not mean that such requirements should remain in perpetuity when conditions change.

A persuasive argument for the abandonment of common carriage lies if the telecommunications marketplace no longer has bottlenecks, essential facilities and monopolies or dominant players with market power, viz. the ability to affect the price or supply of services. Presumably a competitive environment would satisfy all consumer requirements. Incumbent common carriers now face competition from non-common carriers, [17] and it follows to some that a level competitive playing field requires all carriers to incur the same degree of regulation, i.e., eliminate common carrier regulation for all. [18]

Market Failure and Unmet Universal Service Objectives Support Retention of the Common Carrier Classification

Despite progress toward achieving a competitive telecommunication marketplace, even now few users have a choice of local exchange carrier providing essential "first and last mile" services. While proliferating access options, via satellite, wireless and wireline terrestrial facilities, may abate or eliminate such bottleneck control in the future, the vast majority of business and residential subscribers currently access information and entertainment services via a limited set of largely one-way mass media channels [19] and a single twisted wire pair provided exclusively by a local exchange carrier for two-way voice and data services.

Even though the market for local and long distance services will become more competitive, legislatures and regulatory agencies have imposed new requirements that militate against sole reliance on marketplace forces. In developed and developing countries alike, policy makers perceive that without universal service mandates, [20] carriers would deprive rural residence of service, or force them to pay higher "rebalanced" rates, whether cost-justified or not. Whether out of national security or political concerns, these officials attribute the real or perceived unwillingness of operators to provide subsidized services to the hinterland as evidence of market failure. While willingly deregulating common carriers, these policy makers nevertheless maintain a mandatory subsidy mechanism based on the prior service commitments common carriers may no longer have to bear.

Market failure justifications grow even more legitimate in an environment where universal service objective become more robust[21] and therefore even less likely to be achieved absent government intervention. [22] GII visions push the universal service goal beyond access to basic dial tone, i.e., Plain Old Telephone Service ("POTS") and outward to the realm of enhanced services colloquially referred to as Pretty Advanced New Stuff ("PANS").

Advocates for dismantling the common carrier based regulatory regime assume that the proliferation of carriers, networks and service providers makes it more likely that both POTS and PANS will become more readily available. However, others wonder whether seamless connectivity between networks can occur without governments at the very least serving as a referee in position to resolve the likely quarrels over what constitutes full and fair interconnection. [23]

In an increasing number of scenarios, common carriers can select where and whom to serve on variable, market-based terms and conditions. [24] Government officials have not fully come to grips with the consequences of having a business enterprise, historically regulated as a common carrier, also operating in at least some market segments under a significantly different regulatory and legal regime.

As never before historically regulated

common carrier incumbents might encounter robust competition in some markets, or pursue new competitive markets without market share. Under these scenarios they presumably operate without the ability to leverage ongoing market power in non-competitive markets for an artificial competitive advantage in new or competitive markets.

But on the other hand, robust competition has not become a standard condition throughout the telecommunications industry. At least for now, no one can credibly justify complete abandonment of the common carrier classification on the basis of competition in certain market niches. At worst, such action would result in "balkanized" networks, reduced positive networking externalities [25] and higher costs as users and operators find it commercially infeasible to interconnect facilities, despite the technological ease in doing so and the enhanced social welfare that would result.

The telecommunication marketplace has not grown so competitive that the common carrier model should no longer apply to basic services like local and long distance services at least for residential and small business users.

Common Carriage and Internet Telephony

Using the Internet as a substitute for International Message Telephone Service ("IMTS") provides a timely case study for evaluating the consequences of having no common carrier enforcement power. [26] With such a classification regulators could, if necessary, pursue universal service objectives, by conditioning Internet telephony market entry, or alternatively by requiring incumbent carriers to interconnect facilities to make Internet telephony more readily available. [27]

Recently, several software developers and Internet Service Providers have developed audio conferencing programs that digitize speech and make it compatible for real time delivery as data over the Internet. These companies have not reached a single operating standard, nor does the quality or convenience of the service yet parallel conventional IMTS. However, for individuals with access to a recent vintage personal computer equipped with an Internet connection, modem, sound card, microphone and free or low cost operating software Internet telephony translates into extraordinarily low cost telephone access to the rest of the world.

As with all recent telecommunication market entrants, Internet telephony applications will require some degree of access to incumbent local exchange carrier facilities, i.e., the Public Switched Telephone Network ("PSTN"). Residential subscribers to an Internet Service Provider typically access services like Internet telephony via a dial up telephone line. Internet telephony can more robustly contribute to achieving universal service goals, if a seamless connection for the exchange of traffic exists between Internet subscribers and their service providers and the larger set of PSTN subscribers and their telephone companies.

Interconnections already exist between Internet networks and conventional telecommunications networks, in part because a single operator may serve both markets. Likewise, incumbent common carriers consider the Internet a new profit center rather than one that cannibalizes existing revenue streams. The interest in seamless connectivity may wane if incumbent telecommunication carriers begin to see a migration in telephony traffic and revenues to the much cheaper Internet option.

The current manner by which international carriers divide toll revenues encourages users and entrepreneurs to find ways to evade accounting rate payments for IMTS or its equivalents, e.g., private lines that access the PSTN.[28] As Internet telephony grows more prevalent it becomes a more desirable vehicle for achieving universal service goals, at the very time as incumbents perceive it as a business threat to preexisting service revenues and perhaps as well to established universal subsidies for which they qualify as carriers of last resort.

Conventional regulatory and legislative policy correctly justifies leaving Internet telephony as an unregulated software function.[29] But in the future the potential for reaching a critical mass of users and revenue diversion raises two key questions:

1) what should decision makers should do to foster the kind of network connectivity required by the Global Information Infrastructure, particularly when new technologies and service providers can offer service at substantially lower costs if incumbents provide needed first and last mile access at fair rates; and

2) absent a common carrier classification for incumbent carriers, can policymakers simultaneously mandate full and fair interconnection while adjusting universal service policies as needed.

Tentative Answers

Governments can provide productive leadership that can help stimulate development of the Global Information Infrastructure by private enterprises and promote efforts to achieve the still unmet goals articulated by the Maitland Commission[30] regarding conventional services. Such leadership involves "light-handed" regulation rather than conventional "command and control" regulation. Common carrier regulation need not constitute a part of a government's heavy handed regulatory arsenal. On the contrary it provides a core set of expectations for carriers providing key infrastructure elements needed for POTS and PANs. These expectations address a duty to provide service to the public and to interconnect facilities with other carriers, including competitors.

For every refusal to interconnect, or every instance of deliberately overpriced and inconvenient connections, the prospects for a fully connected network of networks grow dimmer. Surely there will be instances where an incumbent carrier perceives a competitive gain in refusing to negotiate in a common carrierless environment.

Absent a mechanism for enforcing interconnection and overseeing the terms and conditions for such interconnection, incumbent carriers may deliberately short change other carriers and users on grounds that their business judgment and strategic vision militates against the maximum feasible degree of connectivity. Should such carriers evade the kind of interconnection duties the common carrier status requires of them, then we will see interconnections occurring only if it promotes the narrow business judgment of two carriers rather than the broader visions of policy makers and the prospective requirements of paying customers.

NOTES

1. See Vice President Al Gore, "Bringing Information to the World: The Global Information Infrastructure," 9 Harvard Journal of Law and Technology 1 (Winter, 1996); Information Infrastructure Task Force, "The Global Information Infrastructure: Agenda for Cooperation," at p. 4, available at gopher://ntiant1.ntia.doc.gov: 70/00/papers/ documents/files/giiagenda.txt; United States Dept. of Commerce, Information Infrastructure Task Force, The Global Information Infrastructure: Agenda For Cooperation, (Feb. 1995); William J. Drake, ed., The New Information Infrastructure Strategies for U.S. Policy, Part III, Policies for the Global Information Infrastructure, (New York, The Twentieth Century Fund Press, 1995); Ilene K, Gotts and Alan D. Rutenberg, "Navigating the Global Information Superhighway: A Bumpy Road Lies Ahead," 8 Harvard Journal of Law and Technology 275 (Spring, 1995); Fred H. Cate, "Global Information Policymaking and Domestic Law," 1 Indiana Journal of Global Legal Studies, 467 (Spring, 1994); Anne W. Branscomb, Roadblocks to the Global Infobahn, The Annenberg Public Policy Center Lecture Series (Philadelphia, University of Pennsylvania 1994).

2. For a complete history of accounting rate regulation by the Federal Communications Commission, see R. Frieden, "International Toll Revenue Division: Tackling the Inequities and Inefficiencies," 17 Telecommunications Policy No. 3, 221-233 (April, 1993); L. Johnson, "Dealing With Monopoly In International Telephone Service: A U.S. Perspective," 4 Information Economics and Policy 225-247 (1989/91); K. Cheong and M. Mullins, "International Telephone Service Imbalances Accounting Rates and Regulatory Policy, 15 Telecommunications Policy No. 3, 107-118 (April, 1991); and K. Stanley, "Balance of Payments Deficits, and Subsidies in International Communications Services: A New Challenge to Regulation, 43 Administrative Law Review 411-438 (Summer, 1991); R. Frieden, "Accounting Rates: The Business of International Telecommunications and the Incentive to Cheat," 43 Federal Communications Law Journal No. 2 111-139 (April, 1991).

3. For a general description of the ITU prior to its major reorganization in 1993, see G. Codding, Jr. and D. Gallegos, "The ITU's 'Federal' Structure," 15 Telecommunications Policy, No. 5, 353 (Aug. 1991); M. Rothblatt, "ITU Regulation of Satellite Communications," 19 Stanford Journal of International Law, 1-25 (1982), G. Codding and A. Rutkowski, The International Telecommunications Union in a Changing World, (Dedham, MA: Artech House, 1982); Jaku, "The Evolution of the ITU's Regulatory Regime Governing Space Radio Communication Services and the Geostationary Satellite Orbit," 8 Annals of Air and Space Law 380 (1983); D. Gregg, "Capitalizing on National Self-Interest: The Management of International Telecommunication Conflict By the International Telecommunications Union," 45 Law and Contemporary Problems 37-52 (1982).

4. For a background on Japan's regulatory structure see Richard E. Nohe, "A Different Time, A Different Place: Breaking up Telephone Companies in the United States and Japan," 48 Fed. Comm. L. J. 307 (1996); Makoto Kojo and H.N. Janisch, "Japanese Telecommunications After the 1985 Regulatory Reforms," 1 Media & Communications Law

Review (1992).

5. See, e.g., See, e.g., Bell System Tariff Offerings, 46 FCC 2d 413 (1974), affirmed sub nom. Bell Telephone Co. of Pa. v. FCC, 503 F.2d 1250 (3d Cir. 1974), cert. denied, 422 U.S. 1026 rehearing denied, 423 U.S. 886 (1975); MCI Telecommunications Corp. v. FCC, 580 F.2d 590 cert. denied, 439 U.S. 980 (1978) (access to local exchange facilities mandated); Establishment of Domestic Communications Satellite Facilities, 22 FCC 2d 86, 97 (1970), policy reaffirmed, 34 FCC 2d 9, 64-5, adopted, 35 FCC 2d 844, 856 (1972), on reconsideration, 38 FCC 2d 665 (1972) (domestic satellite policy mandates non-discriminatory, diverse, and flexible access to domestic satellites and earth station facilities); accord Specialized Common Carrier Services, 29 FCC 2d 870, 940 (1971) (AT&T required to afford local exchange facility access to competing inter-city carriers), on reconsideration, 35 FCC 2d 1106 (1971), affirmed sub nom., Washington Utilities and Transportation Comm. v. FCC, 513 F.2d 1192 (9th Cir.), cert. denied 423 U.S. 836 (1975). Use of the Carterfone Device in Message Toll Tel. Serv., 13 FCC2d 420, recon den., 14 FCC2d 571 (1968)(invalidating local exchange carrier tariff restrictions on interconnection of customer premises equipment with the telephone network); Telerent Leasing Corp., 45 FCC 2d 204 (1974), aff'd sub nom. North Carolina Utilities Commission v. FCC, 537 F.2d 787 (4th Cir.), cert. den., 429 U.S. 1027 (1976); Terminal Equipment Registration, 56 FCC 2d 593 (1975), 58 FCC 2d 736 (1976), aff'd sub nom., North Carolina Utilities Commission v. FCC, 552 F.2d 1036 (4th Cir.) cert. den., 434 U.S. 874 (1977)(preempting the states on the matter of customer premises equipment interconnection with the telephone network).

6. "A firm controlling bottleneck facilities has the ability to impede access of its competitors to those facilities. We must be in a position to contend with this type of potential abuse. We treat control of bottleneck facilities as prima facie evidence of market power requiring detailed regulatory scrutiny. Control of bottleneck facilities is present when a firm or group of firms has sufficient command over some essential commodity or facility in its industry or trade to be able to impede new entrants. Thus bottleneck control describes the structural characteristic of a market that new entrants must either be allowed to share the bottleneck facility or fail." Policy and Rules Concerning Rates for Competitive Common Carrier Services and Facilities Authorizations Therefor, CC Docket No. 79-252, First Report and Order, 85 FCC 2d at 36. See, also, United States v. Terminal Railroad Ass'n, 224 U.S. 383 (1912) (antitrust court ordered railroads to provide competitors equivalent access to bottleneck railway terminal facilities), appeal after remand, 236 U.S. 194 (1915); Cellular Communications Systems, 86 FCC2d 469, 495-96 (1981) (Commission required telephone companies to furnish interconnection to cellular systems upon terms no less favorable than those used by or offered to wireline carriers), modified, 89 FCC2d 58 (1982), further modified, 90 FCC2d 571 (1982); Need to Promote Competition and Efficient Use of Spectrum for Radio Common Carrier Services, 59 RR2d 1275 (1986), clarified, 2 FCC2d 2910 (1987), aff'd on recon., 4 FCCRcd 2369 (1989) (Commission clarified policies regarding interconnection of cellular and other radio common carrier facilities to landline network); Lincoln Tel. & Tel. Co., 659 F.2d at 1103-06 (court upheld Commission's order requiring Lincoln to provide interconnection facilities to MCI); MCI Telecommunications Corp. v. FCC, 580 F.2d 590 (D.C.Cir.), cert. denied, 439 U.S. 980 (1978); Bell Tel. Co. of Pennsylvania v. FCC, 503 F.2d 1250(3d Cir. 1974), cert. den., 422 U.S. 1026 (1975) reh. den., 423 U.S. 886 (1975).

7. In Sable Communications, Inc. v. FCC, 492 U.S. 115 (1989) the Supreme Court upheld a federal statute prohibiting obscene telephone messages, but overturned the statute's absolute denial of adult access via telecommunication common carriers to indecent messages that are entitled to First Amendment protection.

8. See Wold Communications Corp. v. Federal Communications Commission, 735 F.2d 1465, 237 U.S. App. D.C. 29 (D.C. Cir. 1984) (approving non-common carrier leasing of satellite transponders).

9. See Midwest Video Corp. v. FCC, 571 F.2d 1025 (8th Cir. 1978), aff'd, 440 U.S. 689 (1979)(cable television held not to be common carriage).

10. Legislative, regulatory and judicial action have eliminated a bright line dichotomy between common carriers and private, non-common carriers. *See* Eli M. Noam, "Beyond Liberalization II: The Impending Doom of Common Carriage," 18 Telecommunications Policy, No. 6 435-452 (June, 1994); Rob Frieden, "Contamination of the Common Carrier Concept in Telecommunications," 19 Telecommunications Policy No. 9, 685-697 (Dec. 1995).

11. See Rob Frieden, "Contamination of the Common Carrier Concept in Telecommunications," 19 TELECOMMUNICATIONS POLICY, No. 19, 685-697 (Dec. 1995).

12. Professor Eli Noam identifies the demise of common carriage as a predictable consequence of the evolution in telecommunications from a network of networks to a systems of systems. Questions of market access and the terms and conditions of interconnection become less important when networks, service providers and types of players proliferate. But Professor Noam does identify a number of responsibilities, historically managed by common carriers and their government overseers, e.g., universal services, interoperability and physical interconnection. See Eli M. Noam, "Beyond Liberalization-From the Network of Networks to the System of Systems," 18 TELECOMMUNICATIONS POLICY No. 4, pp. 286-294 (1994); Eli M. Noam, "Beyond Liberalization II: The Impending Doom of Common Carriage," 18 TELECOMMUNICATIONS POLICY, No. 6, pp. 435-452 (1994). If common carriers need not address these obligations, or can agree to perform some of them in exchange for further deregulation, what guarantee exists that a larger, more diverse and heterogeneous set of system operators will find it in their enlightened self interest to assume the responsibility? Professor Noam suggests the need for new policy instruments that emphasize neutral interconnection: an obligation to interconnect with and deliver the traffic of any other carrier once a carrier itself seeks interconnection with another carrier. id.

13. "Common-carriage regulation, however, should not be viewed as a panacea. Just because it can be implemented lawfully does not mean that it will work well. Indeed, we suspect that, for most [mass] media, a thoughtful policy analyst will reject the common carrier model." Thomas G. Krattenmaker and L.A. Powe, Jr., "Converging First Amendment Principles for Converging Communications Media," 104 YALE L. J. 1719,1738 (1995).

14. The Telecommunications Act of 1996, P.L. 104-104, 110 Stat. 56, signed into law Feb. 8, 1996, codified at 47 U.S.C. § 151 et seq. (1996).

15. Section 3 (44) of the Telecommunications Act of 1996, codified at 47 U.S.C. § 153(44)(1996) states that a "telecommunications carrier" shall be treated as a common carrier under this Act only to the extent that it is engaged in providing telecommunications services . . . ."

16. Section 401 of the recently enacted Telecommunications Act of 1996, 104 Pub. L. 104, 110 Stat. 56, 128 (1996), codified at 47 U.S.C. 160, Sec. 10 (1996) authorizes the FCC to forbear from applying any provision of the Communications Act and existing Commission regulations when it determines that such oversight is unnecessary to ensure just and reasonable rates, consumer protection and service in the public interest. Quite soon after enactment of the Telecommunications Act of 1996 the Commission initiated a proceeding designed to eliminate the tariff filing requirement for long distance common carriers providing interstate services. See Policy and Rules Concerning the Interstate Interexchange Marketplace Implementation of Sec. 254(g) of the Communications Act of 1934, as amended, CC Docket No, 96-61, Notice of Proposed Rulemaking, FCC 96-123, 1996 FCC Lexis 1472 (rel. March 21, 1996).

17. See e.g., Expanded Interconnection with Local Telephone Co, Facilities, CC Docket No. 91-41, Rep. Or. and Not. of Prop. Rulemaking, 7 FCC Rcd. 7369(1992) (proposing to mandate physical co-location of private carrier facilities on Local Exchange Carrier premises to promote facilities-based competition for local switched services) recon., 8 FCC Rcd. 127 (1992), on further recon., 8 FCC Rcd. 7341 (1993), vacated in part and remanded sub nom. Bell Atlantic, Inc. v. FCC, 24 F.3d 1441 (D.C. Cir. 1994)(deeming physical co-location an unlawful taking of property), on remand, 9 FCC Rcd. 5154 (1994)(proposing virtual co-location); see also Transport Phase II, 9 FCC Rcd. 2718 (1994); Local Exchange Carriers' Rates, Terms, and Conditions for Expanded Interconnection Through Virtual Collocation for Special Access and Switched Transport, CC Docket No. 94-97, Phase I, FCC 95-200, (released: May 11, 1995); see also Transport Rate Structure and Pricing, CC Docket No. 91-213, Report and Order and Further Notice of Proposed Rulemaking, 7 FCC Rcd. 7006 (1992)(Transport is a component of interstate switched access, which LECs provide to enable interexchange carriers (IXCs) and other customers to originate and terminate interstate switched telecommunications traffic. Transport constitutes the local transmission between customer points of presence (POPs) and LEC end offices, where local switching occurs) on recon., 8 FCC Rcd. 5370 (1993) on further recon., 8 FCC Rcd. 6233 (1993), 3d Mem. Op. & Ord. on Recon. and Suppl. Notice of Prop. Rulemaking, FCC 94-325 (rel. Dec. 15, 1994).

18. The FCC appears inclined to eliminate fundamental common carrier requirements to foster a "level" competitive playing field. In early 1996, the Commission substantially deregulated AT&T by reclassifying it as a non-dominant carrier even for most international services and for certain domestic services that it previously viewed AT&T as having market power. *See* Motion of AT&T Corp. to be Declared Non-Dominant for International Service, Order, FCC 96-209 (rel. May 14, 1996); Motion of AT&T Corp. to be Reclassified as a Non-Dominant Carrier, Docket No. 95-427, Order, 11 FCC Rcd. 3271 (1995).

19. "The decentralized, open-access model presents a sharp contrast to the centralized, one-way channel model that typifies most mass media today." Jerry Berman and Daniel J. Weitzner,"Abundance and User Control: Renewing the Democratic Heart of the First Amendment in the Age of Interactive Media," 104 YALE L. J. 1619, 1623 (1994).

20. "The current universal service system [in the United States] is a patchwork quilt of implicit and explicit subsidies. These subsidies are intended to promote telephone subscribership, yet they do so at the expense of deterring or distorting competition. Some policies that traditionally have been justified on universal service considerations place competitors at a disadvantage. Other universal service policies place the incumbent LECs at a competitive disadvantage. For example, LECs are required to charge interexchange carriers a Carrier Common Line charge for every minute of interstate traffic that any of their customers send or receive. This exposes LECs to competition from competitive access providers, which are not subject to this cost burden. Hence, section 254 of the [Telecommunications Act of 1996] Act requires the Commission, working with the states and consumer advocates through a Federal/State Joint Board, to revamp the methods by which universal service payments are collected and disbursed." Implementation of the Local Competition Provisions in the Telecommunications Act of 1996, CC Docket No. 96-98; Interconnection between Local Exchange Carriers and Commercial Mobile Radio Service Providers, CC Docket No. 95-185, FCC 96-325, 1996 WL 452885 (F.C.C.) (rel. August 8, 1996), *citing* Federal-State Joint Board on Universal Service, CC Docket No. 96-45, Notice of Proposed Rulemaking and Order Establishing Joint Board, FCC 96-93 (rel. Mar. 8, 1996).

21. Section 254 of the Communications of 1934, as amended, 47 U.S.C. § 254 (1996) expands the concept of universal service in the United States to include insular areas, such as Pacific Island territories, low-income consumers, health care providers for rural areas, elementary and secondary school classrooms and libraries. Rates for rural health care services shall be "reasonably comparable" to charges for similar service in urban locales, and service provided to meet an educational purpose must be discounted with the difference offsetting the carrier's universal service payments, or qualifying it for reimbursement from the universal service fund. The Section also requires the formation of a new Federal-State Joint Board to review existing universal service support mechanisms, including financial subsidies, with an eye toward recommending new procedures. All telecommunications carriers providing interstate telecommunications must contribute, on an equitable and non-discriminatory basis, to a universal service funding mechanism.

22. Section 254 of the Communications Act of 1934, as amended, requires the formation of a Federal-State Joint Board on Universal Service to recommend changes to any universal service policy. 47 U.S.C. 254 (1996). This Section sets out several guiding principles: 1) access to quality services at just, reasonable and affordable rates; 2) access to advanced services throughout the nation now defined to include low-income consumers, and those in rural, insular, and high cost areas as well as advanced telecommunications services access for schools, health care providers and libraries; 3) equitable and nondiscriminatory contributions by all providers of interstate telecommunications services to universal service funding; and 4) specific and predictable support mechanisms. see 47 U.S.C. § 254(b); see also Federal-State Joint Board on Universal Service, Notice of Proposed Rulemaking and Order Establishing Joint Board, FCC 96-93, (rel. March 8, 1996); reprinted in 61 Fed. Reg. 10499 (March 14, 1996).

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23. See, e.g., Implementation of the Local Competition Provisions in the Telecommunications Act of 1996, CC Docket No. 96-98, Notice of Proposed Rulemaking, FCC 96-182 (released April 19, 1996).

24. See Competition in the Interstate Interexchange Marketplace, CC Docket No. 90-132, 6 FCC Rcd. 5880, 5906-08 (1991), on recon., 6 FCC Rcd. 7569 (1991), further recon., 7 FCC Rcd. 2677 (1992), further recon., 8 FCC Rcd. 2659 (1993), Mem. Op. & Ord. on Recon., FCC 95-2, (rel. Feb. 17, 1995). "Contract carriage would further benefit consumers by unleashing competitive forces for business services to the maximum extent possible. By permitting customers to seek competitive bids from all carriers in the long-distance market--and allowing AT&T to offer customers the same types of contract deals that its competitors are already offering--contract carriage will expand customers' choices." Id. 6 FCC Rcd. at 5880, para. 105.

25. Positive networking externalities mean that an individual consumer's utility increases when an increasing number of other users also consume the same good or service. See Michael L. Katz and Carl Shapiro, "Network Externalities, Competition, and Compatibility," 75 American Economics Review 424 (1985). The concept of direct network externalities reflects enhanced value of service accruing to users. The benefit is considered an externality, because standard economic analysis and the pricing of service may not take into account this outcome. Indirect network externalities result when increasing coverage and market penetration result in more plentiful, lower costing complementary goods. For example, consensus on technical standards Internet telephony can promote global software compatibility and help developers achieve economies of scale by having to support fewer product lines with different formats.

26. For a more comprehensive examination of the regulatory challenges raised by the proliferation of Internet telephony options see Rob Frieden, "Dialing for Dollars: Will the FCC Regulate Internet Telephony?" 22 RUTGERS COMPUTER AND TECHNOLOGY LAW JOURNAL, No.2 (Fall, 1996); see also Provision of Interstate and International Interexchange Telecommunications Services Via the "Internet" By Non-Tariffed, Uncertified Entities; Petition for Declaratory Ruling. Special Relief, and Institution of Rulemaking," Petition of America's Carriers Telecommunication Association, RM No. 8775 (filed March 4, 1996) available via the Internet at http://www.fcc.gov/Bureaus/Common_Carrier/Other/acatapet.html.

27. International message telephone service substantially exceeds domestic rates on a per minute and mileage band basis, primarily because international carriers have negotiated toll revenue division agreements that have failed to drop commensurately with cost reductions. For a discussion of these international accounting rates see Rob Frieden, "International Toll Revenue Division: Tackling the Inequities and Inefficiencies," 17 Telecommunications Policy No. 3, 221-233 (April 1993); Rob Frieden, "Accounting Rates: The Business of International Telecommunications and the Incentive to Cheat," 43 FEDERAL COMMUNICATIONS LAW JOURNAL 111-139 (April 1991).

28. See Rob Frieden, "The Impact of Boomerang Boxes and Callback Services on the Accounting Rate Regime," in D. Wedemeyer and R. Nickelson, eds., Proceedings of the Pacific Telecommunications Council Eighteenth Annual Conference pp. 781-790. (Honolulu: Pacific Telecommunications Council, 1996).

29. On March 4, 1996 America's Carriers Telecommunication Association ("ACTA"), a trade group representing primarily medium and small long distance telephone companies filed with the Federal Communications Commission ("FCC") a controversial Petition for Declaratory Ruling, Special Relief and Institution of a Rulemaking. ACTA alleged that providers of Internet telephony software operate as uncertified and unregulated common carriers in contravention of Commission Rules and Regulations. The trade association suggested the need for regulatory parity: the assertion of jurisdiction by the FCC over the purveyors of software making it possible to use the Internet for telephony and the imposition of common carrier regulation over these software companies. ACTA also stated that increasing use of Internet resources for telephony "could result in a significant reduction of the Internet's ability to handle the customary types of Internet traffic." See Provision of Interstate and International Interexchange Telecommunications Services Via the "Internet" By Non-Tariffed, Uncertified Entities; Petition for Declaratory Ruling, Special Relief, and Institution of Rulemaking," Petition of America's Carriers Telecommunication Association, RM No. 8775 (filed March 4, 1996) available via the Internet at http://www.fcc.gov/Bureaus/Common_Carrier/Other/acatapet.html [hereinafter cited as ACTA Petition]; *see also* Federal Communications Commission, Public Notice, Common Carrier Action, "Common Carrier Bureau Clarifies and Extends Request for Comment on ACTA Petition Relating to 'Internet Phone' Software and Hardware-RM No. 8775," Report No. CC 96-10 (Rel. March 25, 1996).

30. See Meheroo Jussawalla," Is the Communications Link Still Missing?" 16 TELECOMMUNICATIONS POLICY 485 (Aug., 1992); The Missing Link, Report of the Independent Commission for Worldwide Telecommunications Development (Geneva: International Telecommunication Union, 1984).

The Structural Change of International Telecommunications

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Abstract

The thesis depicts the likely structural change of the framework of international telecommunications. The environmental change in the industry as well as the newly challenged measures and services are presented by employing both theoretical and empirical approach. In relation to overall discussion, further perspective of accounting reform, global deregulation model, industry map are also presented. The traditional basic structure, which is still in effect is shifting towards a new one. We are now in the transitional stage of this "paradigm shift".

1. Introduction

Lately, articles of international telecommunications on newspapers and magazines seem to have been on the rise. The World Trade Organization (WTO) is now carrying out negotiations on basic telecommunications. Also, anyone who travels overseas or reads English newspapers can see advertisements for "international telephone services that offer X% discount!"

Even casual observers may have sensed that dramatic changes now beset the state of the international telecommunications industry. What I try to express in this article is some aspects of these changes, namely what reaction these changes will cause in the world, what courses they are currently taking, and the resulting major issues. (Any views in this article are the personal opinions of the author, and are not meant to represent the position of KDD.)

2. The Basic Rules of International Telecommunications

The adoption of the Atlantic City Convention in 1947 by the Plenipotentiary Conference (supreme organ) of the International Telecommunication Union (ITU) had the effect to make the ITU a specialized organ in the United Nations. Afterwards, the elements that form the ITU system (the basic rules of international telecommunications) took concrete shape. Each nation's sovereignty were highly respected partly because these decisions came soon after the end of World War II.

In this paradigm, international telecommunications was essentially considered a common service to be provided by the two terminal nations. The carriers in the two terminal nations concerned (the state or an entity awarded operation privileges by the state) cooperate in providing their respective telecommunications services (mainly as monopolies within their own countries) via telecommunications circuits whose rights they normally share on a 50:50 basis. As the ITU accounting regulations calls on carriers to remunerate the corresponding party for expenses incurred for the telecommunications traffic they originate, both carriers balance the books by making payments to each other based on a mutually agreed accounting rate. Designed to respect the sovereignty of both terminal nations concerned, the principle of the accounting rate system is that there should be no disparity in the level of the accounting rate shares (settlement rate) adopted by both carriers. (See FIGURE 1)

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These basic principle for international telecommunications still applies for the most part today.

The Basic Rules of International Telecommunications
Because of high political meeting of international telecommunications, e.g. the state makes direct provision of a service, political principles take precedence over economic one.(The principle is designed to respect the sovereignty of each nation that underlies joint provisions of international telecommunications)

3. New Structures Emerging in International Telecommunications

3.1 Changes in the Environment around International Telecommunications

(1) Technological Innovation

The convergence between computers and telecommunications enabled certain value-added network services (i.e. e-mail and FAX simultaneous-transmit communications) to develop independently of international telephony calls, and enabled service providers different from network providers to offer telecommunications services.

Also, thanks to increasing efficiency of circuit usage by transmission lines with greater capacity and advances in bandwidth compression technology, we have seen dramatic falls in per-unit transmission costs. All this is in the process of demolishing the premise that international telecommunications are subject to natural monopoly.

(2) Globalization and Diversification of Customer Needs

Whereas attractiveness of store façade and design can prompt shoppers to feel justified in paying higher prices when eating out, buying clothes or whatever, this is not the case with telecommunications services. Here there is little room for non-price competitiveness as the commodity in question is an invisible one; the overwhelming demand in the area of telecommunication services is for services that involve the customer "in the least expense."

On the other hand, however, the increasing numbers of travelers overseas do represent a demand for international telephone services in their own languages. Similarly, escalation of international competition caused many enterprises to require further not only low-cost but also customized telecommunications services in an effort to quicker the decision-making process and boost the efficiency of their business operations.

Additionally, the globalization of the economy with the decline of impediment of national boundaries has brought about greater and more profound dimensions in corporate business activities. As a result, expectations have been growing for such global and seamless telecommunications not based on the conventional "equal-rights communications circuit splitting process".

(3) Deregulation and Competition

The international telecommunications in every nation have developed as undertakings with a high public-utility factor that have, in historical terms, served as extensions of the railroad and postal businesses. In many countries, international telecommunications have been under operation of the national governmental, and even where they have been placed in non-governmental hands, measures have always been taken to exclude any tips of foreign entities. However, moves toward deregulation and competition have since begun as a result of the need to accommodate the transformations in supply and demand outlined in (1) and (2) above. These moves first appeared in the USA, subsequently spreading to the UK and Japan, and currently, deregulation and competition, giving priority as they do to the interests of the consumer, are sweeping across the globe.

Forms of deregulation and competition in the international telecommunications industry are also apparent among the carriers themselves (the so-called wholesale market), e.g. connections with other carriers and so forth.

3.2 Examples of New Developments

In this section, I wish to present some actual examples of arrangements in which traditional supply systems, networks or services of international telephone on the wholesale and retail markets are being bypassed.

(1) "Home Country Direct"

(A move on retail markets to bypass outgoing international telephone services)

This is a system in which the carriers of various nations let travelers overseas have a special telephone number which they can dial to be put through to that carrier's operator (or automatic voice system). The carrier then puts the call through to the party called, treating the call regularly as an originating call from the nation of the carrier. The charges for such calls are either paid for by credit card or settled by the recipient of the call on a collect-call basis. This kind of service represents a "strategic commodity" in the arsenal of the carriers, who wish to substitute originating calls from the countries of the carriers for those originating overseas. Such services do appear to be increasingly popular, as they serve in providing greater convenience of use to travelers overseas who cannot handle the local language or do not have local currency.

(2) "REFILE" (See the diagram below)

(A move on wholesale markets to bypass the supply system of international telephone)

The carriers or resellers (hereinafter, referred to as "REFILE provider") of various nations (nation B in the diagram below) acting in agreement with the carriers where the calls originate (nation A in the diagram below), place the originally direct calls (calls originating in nation A bound for nation C) to nation C, without the agreement of carriers in that country. Generally, REFILE providers receive from the carrier originating the call charges that are lower than the accounting rate, subsequently paying a sum equivalent to the accounting rate to the carrier in the country of the call's final destination. However, the REFILE provider cannot make a profit on this call if it is established as a direct call from the originating carrier to the carrier in the country of its final destination. Consequently, the REFILE providers are engaged in a bid to make a profit (albeit a small one) by affording the originating carrier an advantage of lower outpayment. (See FIGURE 2)

(3) "Callback"

(A move on retail markets to bypass international telephone services)

This is a type of resale service whereby a caller dials up the reseller's exchange facilities in such country as, say, the USA, where he lets the phone ring once before instantly hanging up. The caller then waits for this exchange facility to "call back," giving him a dial-tone for dialing the destination number, thereby making an international call that originates in the US. Basically, this system works by taking advantage of the disymmetry in collection charges of international call existing between various countries, with the reseller setting up exchanges in countries where dialing rates are comparatively cheap, i.e. the US and the like. In the background lies intensifying competition on the US telephone market. To cope with this, US carriers offer discount rates and even greater discount for individual contracts, which presumably leads to the existence of the resellers, who buy up wholesale bulk from the carriers at bargain prices.

(4) "International Simple Resale"

(A move on retail markets to bypass international telephone networks and services)

Resellers rent international leased circuits between two nations from the carriers in the two respective nations. The resale businesses then introduce their own exchanges into these international leased circuits and provide international telephone services etc. to a large number of unspecified or specified customers by connecting up with domestic or international public networks or leased circuits. This type of service will become freely available to a restricted number of developed countries such as the US, the UK, Canada, France, Germany, Sweden, Australia, New Zealand, etc. by January 1998 at the latest. The liberalization of international simple resale has also made steady headway in Japan, too.

(5) "Internet"

(A move on retail markets to bypass international telephone networks and services)

The Internet is the general description of a worldwide telecommunications network for carrying out communications by means of TCP/IP protocol (to define the communications procedures etc.). A great number of users will no doubt find that use of the Internet for data retrieval, e-mail, etc. (at a fixed basic rate) is cheap and convenient. Last year the marketing of "Internetphone" by the US company VOCALTEC will probably lead in the future to a combination of data-related services and voice services becoming the principal applications. At all events, the Internet has the potential to replace international telephone networks as a communications network of the next generation. The Internet owes its present form to advanced US starters in the field allowing later starting enterprises to make connections. I would like to point out that such partial development of the internet should be discussed.

3.3 New Structures of International Telecommunications

The collective influence on the basic rules of international telecommunications of the changes in the environment outlined earlier in section 3.1 and the new developments cited in section 3.2 above will in all probability have the ultimate effect of carrying through market principles and turning international telecommunications services into commodities.

(1) Orientation Toward Purchasing at Low Wholesale Prices

Carriers in various liberalized nations are seeking to make even the slightest reductions in the costs incurred in originating calls. They are making strong demands of their overseas partners to bring down their accounting rates, by insisting on new remuneration systems for incoming calls, and by accepting offers from REFILE providers to avail themselves of the REFILE system. This is a clear evidence that the advance of free competition and deregulation in various nations has begun to necessitate that carriers make efforts to cut back on every

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little expense. Not only this, but despite their traditionally monopolistic role of providing telecommunications services under the conventional state-run system, they are now locked in a bid to cut back, by dint of their own independent efforts, on fixed expenses such as labor costs etc. so as to maintain their profitability.

(2) Traffic-Hub Orientation

What such services as "home country direct", "callback" and "REFILE" show us is that the carriers and resellers of various nations are aiming at every bit of profit that can be squeezed from their telecommunications operations by concentrating as much international traffic into their own nations as possible. This, as has been noted in (1), is in itself evidence that, for all their erstwhile positions as monopolistic suppliers of telecommunications, carriers are now feeling the necessity of boosting turnover wherever they can and ensuring that as much of their networks is in use as possible, in an attempt to secure profitability. However, increased fierce competition worldwide directed at creating hubs of international telecommunications is, some feel, likely to cause the international telecommunications network to assume a "hub-and-spoke" structure. Such a phenomenon, it has been pointed out, would threaten the stability of supply of international telecommunications.

(3) Orientation Toward the Introduction of Fixed Rates

NTT is due to launch its OCN (Open Computer Network), which is based on a fixed rate system whereby communications will be available at a standard rate, irrespective of duration of communications. Further, the final report issued (May 1996) by the Ministry of Posts & Telecommunications' "Study Group into Universal Service & Charges in the Multimedia Age" advocated the introduction of a variety of fixed rates so as to promote usage of the Internet. Providers are feeling the need for the competitive introduction of these fixed rate systems in order to boost usage among their customers.

(4) Orientation Towards Renouncing Traditional Joint Provision of International Telecommunications Services

As noted earlier, carriers still, as a general rule, provide international telecommunications services jointly whereby they have the responsibility to provide those services within their own countries. However, big users such as multinational corporate enterprises and the like claim that these carriers do not cater to global seamless demand. As a result, national carriers risk losing some of this multinational corporate sector. The upshot of this is that a single carrier or a group of carriers is now making moves to provide comprehensive telecommunications services over a range of nations, and not just their own. In this connection, a lot of attention is being focused on such aspects as the much-talked of inter-carrier alliances (WORLDPARTNERS, CONCERT, etc.), the setting up of commercial points and resale subsidiaries in partner nations, and the global development of resellers.

New Structures of International Telecommunications

As a result of private enterprises providing international telecommunications services as a commodity, political principles will give way to those of the economic world (i.e. the realization of market principles such as cheaper purchasing, expanded sales routes, and the attainment of maximum possible profit margins).

4. Examinations in International Organizations

In response to the structural change in international telecommunications, outlined above international organizations concerned have been reviewing the situation along the following lines.

4.1 The World Trade Organization's (WTO) Negotiation on Basic Telecommunications

Telecommunications services were taken up as one of the subjects dealt with in the first ever service trade negotiations that took place during the GATT Uruguay Round (1986 to 1994). However, since the conclusion of this Round had only basically led to agreement by the countries concerned regarding the deregulation of value-added network services, it is the Negotiation on Basic Telecommunications held subsequently that will have the greater effect on the structural change in international telecommunications. One of the focal points to have emerged from the Negotiation on Basic Telecommunications is the opening up of international telecommunications (ISR), as well as the abolition of foreign ownership restrictions and the setting up of competitive safeguards. In order to ensure fair competition, it had been recognized to limit the deregulation in the case of monopolistic operators in non-deregulating nations. However, just before the initial closing date (April 30, 1996) of the negotiations, an attempt on the part of the US to extend these limitations to the main operators of deregulating nations as a form of ex-ante entry regulation (on grounds of essential reciprocity) led to a prolongation of the negotiations (new closing date: February 15, 1997).

4.2 ITU-T/SG3 (General Principles for International Telecommunications Tariff and Rates)

1991 saw the revision of Recommendation D. 1, which was designed to seek greater recognition for use by others of international leased circuits lines and for reselling practices. Then in 1992, Recommendation D. 140 was created, which advocated that the accounting rates of international calls should be cost orientated. Moreover, in March of this year, the SG3 formulated the draft resolution with callback issues by the World Telecommunications Standardization Conference and looked into the issues surrounding REFILE.

During the next study period (1997 to 2000), new frameworks are to be drawn up for tariff and rate systems and competition safeguards that are in line with realistic telecommunications structures.

4.3 Organization for Economic Cooperation and Development (OECD) Information, Communication &Computer Policy Committee

Although the OECD has a popular reputation for being a "salon gathering of developed nations and so forth", its Information, Communication &Computer Policy Committee basically functions as a body without legally binding powers and serves consumer interests by offering policy initiatives based on documents drawn up by their administrative department.

In 1992 this body examined the effects of the public disclosure of accounting rates on accounting rates and collection charges, and in 1994 it conducted a study into the similar effects of REFILE and alternative calling procedures. Subsequently, it has been looking into the diverse issues, e.g. the kind of effect the Internet has on accounting rates.

4.4 Asia-Pacific Economic Cooperation (APEC) Telecommunications Working Group

Ever since the unofficial Seattle Summit presided over by US President Clinton, APEC has come to assume a role of increasing importance. The Telecommunications Working Group has been engaged in a variety of activities, which have included the 1994 compilation of guidelines for international value-added networks (IVANs). The reorganization of Telecommunication Working Group's infrastructure has recently resulted in the formation of the Deregulation Management Group, which is expected to discuss the various issues involved in the deregulation etc. of investment, market access, and others.

5. Concluding Remarks

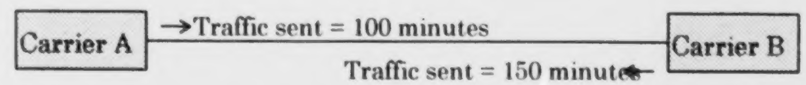
The structural change in international telecommunications that I have outlined above came to be sufficiently recognized as such during the mid-1980s, when deregulation and moves toward free competition began to show themselves. Only recently, however, has the change become radically evident throughout the world, including Japan (particularly in Japan, where the financial repercussions affect international telephone revenues that account for between 80 and 90% of the income of the international Type-I telecommunication carriers). In this context, therefore, international telecommunications operators will have to act in accordance with the prevailing laws of competition by steadfastly seeking to curtail all manner of costs, expand sales routes to the maximum possible degree, and optimize profit margins. We are no strangers to such measures, and our future survival depends on our pursuing them yet further. However, the costs of every material including lands and employees would be relatively higher in our country (Japan). Therefore, we cannot fully lower our costs to the level in other nations and it may be beneficial for us even to move our main commercial presence to other countries with lower costs.

It goes without saying that we are going to stand in need of policy measures to cope with the structural revolution in international telecommunications that I have just outlined. As section 4 indicates, all manner of international organs are already examining ways of coming to terms with this revolution. Certain countries including the US are, as a matter of policy, surveying how things stand as to regulations and so forth in its partner nations with an eye to the granting within its borders of international telecommunications operating licenses.

Amid escalating international competition in such fields as international telecommunications, one of the key factors in any policy measures taken to deal with this will, I believe, be the formulation of policies designed, for instance, to preserve and bolster our competitive interests in the face of monopolistic operators in monopolistic nations. This will involve devising ways to curb the practices of such operators, backed as they are by their monopolistic profit margins, should they seek to misuse their dominant position on the international telecommunications market. However, even developed countries such as the US are taking policy measures designed to ensure the profitability of carriers in their own countries. Amid such international competition, we in this country are likewise called upon to adopt a course of policy to ensure our national interests in the widest possible sense. In so doing, we should bear in mind that we need to put the interests of our consumers first, while securing the financial resources to establish international networks. In order to identify the directions these policies are to take, it may well be necessary for us to discuss fully these structural changes.

ILLUSTRATIONS

FIGURE 1: EXISTING ACCOUNTING PRINCIPLE

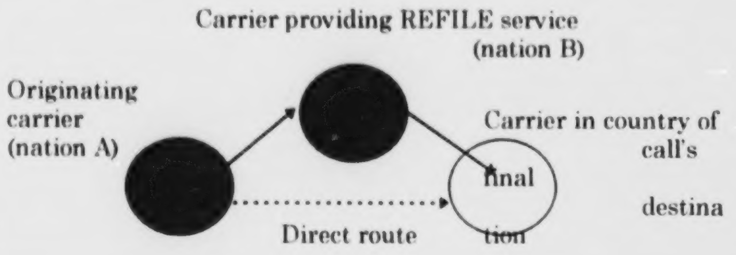

Carrier A
→Traffic sent = 100 minutes
Carrier B
Traffic sent = 150 minutes←

Accounting rate shares = ¥100

In this instance, B pays A the sum of ¥5,000, i.e.

(150 - 100) x 100

FIGURE 2: REFILE


Carrier providing REFILE service
(nation B)
Originating
carrier
(nation A)
Carrier in country of
call's
final
destina
tion
Direct route

Online Services And "Transactional Space"

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1. ABSTRACT

Structural changes in the media are leading to the development of media systems where limited channel capacity is giving way to information, entertainment and channel abundance. In future media and communications environments, control over "channel space", and to a lesser extent control over "program content", will lose its strategic importance. It is argued that another aspect of the new media environment, described as "transactional space" will become the strategic resource of the future. According to this analysis, the creation of transactional spaces and the control of the transactions which occur in those electronic spaces will lead to a radical reworking of the political economy of media and telecommunications systems.

2. INTRODUCTION

We are all familiar with public discussion of what has become known as the "information superhighway". This discussion is suffused with images of abundance, freedom and the shrinking of distance. Digitisation and fibre optics are seen as providing an almost unlimited number of information and entertainment channels to the home. In a similar vein, the Internet is seen as the gateway to an ever-changing, expanding and limitless universe of information sources. New media are seen as way of bringing information and entertainment instantly from around the globe (Broadband Services Expert Group, 1994). These images of an information and entertainment cornucopia are an integral part of the public discourse about the future of the new media. Coupled with the idea of information and channel abundance is the notion that the digital electronic world being created is somehow beyond the realms of existing social, political and physical constraints. Discussions of cyberspace present it as existing in a kind of science fiction netherworld beyond the boundaries of local, national and international governments, and as a zone where new kinds of non-spatial communities are being formed (Jones, 1995).

But will channel abundance and the practical limits of governments' ability to regulate the content of online services lead to a free-wheeling democratically accessible marketplace for online services? Will channel abundance reduce the significant economic and political power which previously resulted from control over one of the limited number of broadcasting channels? In other words will control over "channel space" lose its strategic benefits?

If the images of an information and entertainment cornucopia were to guide our thinking, and if we were to accept the view that "electronic space" is both indeterminate and beyond effective control, it is possible to assume that the emerging media systems will result in a diminution of the kind of power which had been exercised by the controllers of scarce broadcasting channels in the past. It could be argued that this power will be diluted so that large and small organizations without any previous involvement in the media, together with the powerful and powerless will find themselves on more equal terms when it comes to the distribution of information and entertainment on the abundant channels of the future.

But is this likely to come about? One analysis suggest that the contradictions which were inherent in the old order encouraged the development of transformatory forces which we are now experiencing (Harvey, 1973). It could be argued that the emerging media environment grew out of the contradictions which were inherent in the old environment. In the past, monopoly or oligopoly control over limited broadcasting channels led aspiring entrants to mobilize government and public support for the introduction of alternative cable, satellite and broadcast distribution systems. Similar movements occurred in the telecommunications

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industry. Monopoly and oligopoly control of telecommunications was seen as artificially limiting channel capacity, stifling technical and service innovation and protecting incumbents from the rigors of price competition. As a consequence, telecommunications industry re-regulation has seen the introduction of new competitive telecommunications regimes worldwide. As with broadcasting, the emerging telecommunications environment provides for abundant and diverse communications channels and services provided by a range of new players.

But this same analysis suggests that the contradictions which were inherent in the previous industry structures will emerge in new forms, as players in the new industry environment attempt to develop new forms of competitive advantage. In this paper I will argue that new forms of strategic power and control are emerging and that these are based on what I call "transactional space". The core of the argument is that power based on access to and control over limited "channel space" is giving way to control based on "transactional space". In order to support this contention I plan to argue for the adoption of a spatial metaphor for understanding and framing questions about the development of the emerging media and telecommunications systems.

3. THE SIGNIFICANCE OF METAPHORS

Sawhney has argued that the metaphors or conceptual frameworks which we use make sense of new technologies can be either emancipatory or limiting. But because explanatory metaphors for new technologies are often drawn from our understanding and experience of previous technologies, the new technologies are often cast in the image of the old. For example metaphors based on the railroad industry were the basis of understanding and regulating the telegraph system. In turn, metaphors rooted in the form and function of the telegraph industry guided conceptualization and regulation of the telephone system (Sawhney, 1996; 295).

The metaphor of the "information superhighway" has come to stand for the Internet and other high capacity communication systems which move information from place to place using telecommunications systems linked to computers. Given the previous discussion it is useful to clarify the implications of this metaphor. As with concrete and steel superhighways, the information superhighway metaphor can be used to direct attention to some important social and political issues. The information superhighway can be seen as marginalizing some groups and privileging others, it can ignore and destroy neighborhoods and emphasize the needs of commercial and government traffic.

But a fundamental problem with the information superhighway metaphor is that the superhighway transportation model ignores the fact that unlike superhighway transportation, telecommunications transportation is essentially instantaneous. It is this instantaneity which makes the "information superhighway" metaphor potentially misleading. With traditional superhighways, it takes time to traverse distance, but with "information superhighways" we have a new kind of "distance" which takes no time to traverse. Perhaps we need to consider the consequences of a new kind of "distance" which can be traversed instantaneously. If it is possible to suggest that if we have a new kind of "distance", perhaps we can start to imagine the emergence of a new kind of "space"?

4. "DISTANCE" AND COMMUNICATIONS RESEARCH

That the emergence of new media and communications systems should encourage us to re-examine our notions of distance and space should come as no surprise. Debate about the social, political and economic implications of distance-spanning communication technologies have had a long history. For example Innis (1950, 1951) examined the role of communications systems in extending the power of "empires". New media such as the telegraph, radio and television made it possible to exert control over extended geographical space. Schiller (1969) extended this analysis to provide a specific critique of American imperialism based on control over media production, telecommunications and satellite distribution systems, systems which extend the geographic reach of American cultural products. And Beniger (1986) reveals the centrality of information storage, processing and transmission to the development and control of complex, geographically extended organizations which supply goods and services.

The significance of geographical extension has become an integral part of theorizing about the new media. Poster discusses the implications of electronic communications for "greater spatial and temporal extension" and of electronic writing which increases the spatial and temporal distance of the author from the reader (Poster, 1995; 59,69). He also notes that the new media undermine the territoriality of the nation state (Poster, 1995: 28). A parallel point has been made by Morley and Robins (1995) in their examination of the consequences of the new "distance-spanning" global media for local identity in a European context. They conduct their discussions in the light of the deterritorialization of audiovisual production and the continuing development of transnational delivery systems. While the political and technological context is new, they elaborate a generic issue which was raised by Tunstall (1977) almost twenty years ago.

These analyses focus on the relatively unproblematic distance-spanning characteristics of media and telecommunications systems. They are concerned with the collapse of distance as an impediment to action, and to the actions which this new distance-independent world make possible. But a single-minded focus on the disappearance of distance diverts attention from the possibility that while distance is being annihilated, something else might be being created.

5. THE SOCIAL PRODUCTION OF SPACE

Social theorists have begun to recognize that the reconstitution of time and space is at the very core of what Giddens has described as the "juggernaut of modernity" (Giddens, 1990;139). Soja also suggests that space is a product of social translation, transformation and experience, and as a consequence it should become an object of critical social discourse. For him, organized space is not a separate structure with its own autonomous laws of construction and transformation or just an expression of class structure. Rather the structure of organized space represents..

> ... a dialectically defined component of the general relations of production, relations which are simultaneously social and spatial. (Soja, 1989;78)

Changing the relations of production could lead to the restructuring of organized space.

Lefebvre also argues that while the thought of "producing space" might sound bizarre, space is "socially produced". He notes that social and economic changes produce changes in the meaning and significance of space. And that while social and economic changes alter the nature of existing spaces, capitalism and neo-capitalism have produced a new kind of "abstract space" which is based on

> ..the vast networks of banks, business centers and major productive entities, motorways, airports and information lattices. Within this space the town - once the forcinghouse of accumulation, fountainhead of wealth and the centre of historical space - has disintegrated (Lefebvre, 1991;57).

He suggests that while old spaces disintegrate, new spaces are created. These new spaces are organized according to the specific requirements of the state and its constituents. (p.85) New spaces and developments in productive forces eventually give rise to new modes of production (Lefebvre, 1991;103).

According to Soja postmodem critical social theorists have begun to reconceptualize the spatiality of social life and to emphasize..

> ..the instrumental power which adhere to the organization of space at many different scales, the increasing reach of this instrumental and disciplinary power into everyday life as well as more global processes of capitalist development, (and) the changing and often contradictory power relations wherever they are implanted (Soja, 1989;128).

While the organization of space has been implicated in the creation and exercise of power, a parallel argument has been made about the new media. Murdock has argued that..

> The history of communications is not a history of machines but a history of the way that new media help to reconfigure systems of power and networks of social relations..... (Soja, 1989;533).

So how might we fruitfully explore the new media and telecommunications systems from a perspective which deals with new configurations of power and the creation and organization of space?

6. MANUFACTURING ELECTRONIC SPACE?

We are all familiar with conventional transactional spaces in our everyday lives. Shops are where merchants display goods, shoppers make purchasing decisions and where funds and goods are exchanged. Courts are associated with legal transactions and schools with educational transactions. We are used to the idea that transactions occur in specialized, often purpose-built physical spaces. But the new media and telecommunications systems are leading to the development of equivalent electronic transactional spaces. While we go to a bank or an automatic teller machine in order to deposit a cheque, the underlying transaction which results in my account being credited or debited now occurs as an electronic transaction on a bank's computer. If the transaction involves more than one bank, the transaction could occur in a computer associated with a banking clearinghouse as well as the two participating banks.

The move towards the digitization of information means that computer-based transactions are taking the place of transactions which occurred in purpose-built physical spaces. The physical clearinghouse operations of banks have been supplanted by digital computer-based clearinghouses. Parallel changes have occurred in the telecommunications industry. As switching information has become digitized, the physical connection of two circuits originally made by switchboard operators and later by electro-mechanical exchanges has given way to the routing of two information streams by a digital telephone exchange, which is on fact a special purpose computer. The switching process routes the call through the network, collects information about the identity of the calling and the called parties, the time and duration of the call and communicates that information to the billing system. Where this would have been done manually or mechanically in the past, these physical transactions have been superseded by electronic transactions which occur in the electronic space owned and controlled by the telephone company. Following Lefebvre (1991) we can see that a new electronic "transactional space" has been manufactured.

In the telephone industry, the transition to digital switching has meant that a new class of information is being generated. This is information about the transaction itself which McManus (1990) has described as Transaction Generated Information (TGI). In the case of an ordinary telephone call, the telephone company has among other things, digital information which identifies the number of the calling party, the time of the connection request, and the number of the called party. In the past this information would have been used as a part of the switching, billing and routing systems. But this information is of crucial importance to the telephone company because it can be re-used or re-processed for quite different purposes. For example Calling Number Display (CND) involves the re-use of the information which identifies the caller and the transmission of that information to the called party. Once, this information would only have been of internal use to the telephone company, but now this TGI can be repackaged and onsold as an additional service and source of revenue. As a consequence, a range of Custom Local Area Switching Services (CLASS) services has been developed.

The Calling Number Display service has been the subject of heated debate because critics have argued that telephone callers are entitled to have the ability to make calls which do not identify them to the called party (White, 1992). They argue that just because the telephone company has access to the information identifying them for switching and billing purposes, the company does not have the right to onsell that information to others.

The controversy over the introduction of CND which is essentially the reuse of Transaction Generated Information is the first clear example of a debate over what should or should not occur in an "electronic space" which in Lefebvre's (1991) terms, has been "created" for the telephone companies by the switch manufacturers. This is what I will call an electronic "transactional space".

In the case of Calling Number Display, the public policy debate has been about the rules which should govern the transactional space, and how transactionally generated information should be used. The fierce battle for control of transactional space associated with the switching of ordinary telephone calls is a pointer to the strategic and commercial significance of other transactional spaces in the future. Control of that space confers great commercial and strategic advantage.

7. NEW TRANSACTIONAL SPACES

There are strong financial and strategic reasons for all companies to become more interested in gaining financial and strategic leverage from their existing transactional spaces and in developing new ones.

This is occurring quite clearly in the telephone industry because telephone companies are facing competition from two fronts. On the one hand the costs of providing transmission capacity are dropping rapidly because of the introduction of fibre into networks by incumbent carriers and their competitors. At the same time cellular wireless systems and emerging satellite systems will provide additional transmission capacity for competitors and place further pressure on the profitability of the information transmission part of their business. It is possible to see that the information transmission business is becoming a commodity market, with rates only marginally above the cost of supply.

The other significant competitive threat is from the growth of transaction processing devices in the premises of telephone company customers. These devices can switch, store and serve information for use within a customer's own network. But if these devices are connected to the public network, they can mimic many of the functions which were once solely in the domain of the telephone company.

The Internet provides a useful example of a system which only uses the transmission capacity of the telecommunications network and which places much of the network intelligence on the premises of its users. Based on open, non-proprietary standards and the lowering costs of computing, the academic and research communities have developed a range of information services which can provide international access to text, image and sound services. When we take a historical perspective it is possible to see some Internet services as an improved version of electronic mail and videotex services such as Prestel and Viatel which were once telephone company monopolies. What we see with the Internet is that its processing or transactional space is located in computers located in Universities, research organizations, and commercial organizations. The only service provided by the telephone company is the low-profit transmission capacity. In essence most of the intelligence and transactional spaces have moved off the telephone network and into the premises of its customers.

The development of call switching and information processing capabilities outside the telephone network and in the premises of users could be seen as a transformation in response to contradictions which are inherent in the telecommunications system. A lack of innovation and high charges for services encourages users to resolve those contradictions by creating "intelligent", computer-based transactional spaces on their own premises. This "out-migration" from telecommunications network leaving low-profit margin information transmission to the carriers then leads to the carriers seeking to enter the business of Internet provision and value added services themselves.

The commercial and strategic value of transactional spaces which can be owned or controlled has not been lost on other information-based organizations. An early successful attempt to create such a space was made by Reuters, an international news services. As a wholesaler of news and information to newspapers, and broadcasters, the news services were faced with a declining market, a loss of Government subsidies and increasing competition (Kingsley, 1992;178). United Press International became bankrupt in 1984 and Associated Press only survived when its owner-members decided to increase their contributions rather than switch to another source of news (Schwarzlose, 1992;154). The most successful response to this business threat was made by Reuters which had discarded its old and slow telex-based distribution methods and developed its own computer-based network to distribute its information service. During the development process it was realized that a computer-based distribution service could be used for transactional services as well. As a consequence it developed what became the Reuters Financial Network. Apart from delivering financial data to business subscribers, it created an online market for the very commodities which were originally only the *subject* of that information service. Subscribers could use the service to both monitor the market, and trade in the commodities themselves (Read, 1992;297). Essentially Reuters had created a transactional space which was to become extremely profitable and bolster the finances of the organization (White, 1993). Without the profits of Reuters Economic Services and, to a lesser extent the profits of the Associated Press Dow-Jones financial information service, the combined losses of the agencies would have been US$15 million by the start of the 1980s (Fenby, 1986;124).

Most recently, Microsoft developed, launched and then wound down the Microsoft Network. In essence this network was a proprietary version of the Internet which allowed subscribers to transact business with publishers and other service providers. This move into online transactional services was an attempt by Microsoft to expand its revenue base to include commissions from financial transactions conducted on its network. Microsoft attempted to use its control of the desktop operating system market to link personal computers to its information service over the telephone network. It was refocusing its activities beyond that of a software supplier to a transactional service provider by creating its own proprietary transactional space.

While Microsoft has abandoned the development of a "proprietary" Internet, its involvement in a "browser war" with Netscape Communications signals a battle over a new kind of transactional space. For the online user, his or her World Wide Web browser is the starting point and window on the Internet. It is the place where all journeys into the Internet commence, and it mediates a user's interaction with the Internet. Microsoft has realized the significance of the browser and its strategy appears to be one of integrating the functions of a browser into its software offerings. With the browser an integral part of a user's software, the Internet and its networked resources appear as an extension of the resources which reside an a user's personal computer. (This both extends the range of available resources and enhances the value of Microsoft's software.) But in doing this it makes competing Web browsers redundant and more importantly it places Microsoft software at a pivotal point in the transactions which a computer user makes with the resources on the Internet. Thomas Reardon, Program Manager for Microsoft's Internet and Platform Tools Division has said that the browser will disappear and "the desktop becomes the browser" (Freund, 1996:124). Whether this interface between a computer user and the Internet is a World Wide Web Browser or an integrated suite of software programs, it can be seen as a software created "transactional space" which can confer significant power on the organisation which controls its design and configuration.

8. CONCLUSIONS

This preliminary analysis shows how thinking about the nature of online services and the new media can be informed by the theoretical literature which deals with space and modernity. Most particularly, the new media can be seen to be implicated in the manufacture of space. "Spatiality" provides a new way of theorizing about the nature of the new media, and a supplier of a new metaphor for conceptualizing the issues. Transactional spaces could be seen as adding value to existing services by providing intelligent indexing, searching, profiling or linking facilities. On the other hand these transactional spaces could add value to the providers of content or services by exposing their content or services to predefined groups of users, as well as providing audience measurement or billing services.

Whether these software-based transactional spaces are called menus, indexing services, interfaces or just electronic places which people visit, these environments will have the same significance as other more tangible, physical public spaces such as entertainment centers, art galleries or shopping malls. An attractive and functional transactional space will be a precondition for the provision of online services. Applying a similar notion to future interactive advertising, Steve Hayden has argued that marketers and media developers need to "create intriguing environments for people to visit..." (Johnson, 1995:135).

Public policy and industry development strategy should acknowledge that the creation of transactional spaces and that the control over the transactions which occur in these spaces will lead to a radical reworking of the political economy of media and communication systems. In an era of information, entertainment and channel abundance, where consumers are not constrained by the limited choices provided by the broadcast media, transactional spaces will be the places where audiences, program providers and information service providers meet. This means that appropriately designed transactional spaces will be of crucial significance in the online economy of the future. In commercial terms, transactional spaces will become the strategic battleground for control of media and communications systems in the future.

If this analysis is correct, and control of the "content" of future online services will be secondary to the control over transactional spaces, a number of policy issues emerge. First, market power in online services will accrue to organizations which can develop the most attractive and functional transactional spaces. As has been discovered with the Internet, while communication standards are open and non-proprietary, the range of potential online service providers is large. But if those standards become proprietary, it is possible that access to the online service provider market will be restricted to the organizations who either control those standards, or who can afford to purchase rights to those standards. Second, the privatization of standards could also result in the segmentation of online services along economic lines. Proprietary

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standards developed for commercial services may restrict general public access to those services and a tiered online service market could emerge. Third, online service users will need to be assured that the information which they share in these transactional spaces will be used in ways which they approve. Privacy and security regimes which meet the needs of all parties will need to be developed. And finally, if the existing large media players, the publishers, broadcasters, film studios and telecommunication companies emerge as the controllers of the major transactional spaces, any hopes for a democratic flowering of online services will be short-lived.

9. NOTES

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NOTES:

The Availability of Interactive Media to Perform Better Educational Services to Individual Open University Students

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Abstract

Universities, no less than other organizations are challenged by the age of convergent communication technology. Connectivity amongst "players" is not only increasingly possible but highly desirable in an environment at once competitive and collaborative. This paper provides an overview of convergent communication initiatives in Indonesia through the experiences of Universitas Terbuka, the Open University of Indonesia. Recently, UT has explored links with other universities around the Pacific Rim. The paper acknowledges these links and in particular outlines an emerging Multimedia Educational Project with Edith Cowan University in Australia. Universitas Terbuka and Edith Cowan University share problems associated with effective and efficient delivery of courseware ural and remote students. Moreover, both universities must build an effective skill base covering network expansion and control, and courseware development and enhancement. The policies and practices employed by Edith Cowan University and Universitas Terbuka outlined in this paper may be helpful to other universities with similar problems.

Introduction

Interactive media innovations, such as telephone-based teleconferencing and computer conferencing systems, have successfully supported education in the United States of America, Australia, Canada and Europe. The Rural Satellite Program Projects in Indonesia have demonstrated that teleconferencing is an efficient and effective means of delivering training and instruction over vast distances to isolated and remote audiences in order to create high human touch as an accompaniment to one way media. Likewise in Australia, telecommunication has been used effectively to deliver courseware interactively to students in rural and remote locations over considerable distances

This paper provides an overview of telecommunications developments in Indonesia with particular reference to opportunities for educational delivery and interactivity. The paper profiles the Open University of Indonesia (Universitas Terbuka) and Edith Cowan University where innovative delivery

systems are being developed, explores collaborative arrangements between the two universities and surveys future options.

As the title suggests, we are concerned here with three inter-connected themes: the impressive and at times spectacular advances in communication technology, the use of these achievements by two universities to enhance delivery of courses to enrolled students and the need for a collaboration between universities and with industry to maximize educational effectiveness.

Three assumptions underpin this paper:

(i) convergent communication technologies will continue to improve our access to rural and remote communities;

(ii) all university courses will benefit from interactive multimedia delivery both as a discipline for course developers and as an improved form of learning for some students.

(iii) interactive multimedia delivery will attract and benefit on-campus as well as distance education students.

Telecommunications in Indonesia

In Indonesia, according to the Guidelines of State Policy (1993), telecommunications development is aimed at supporting an increase in national development by accelerating the flow of information. Telecommunications are continually being developed and have already become a reliable vehicle for carrying out the flow of news, information, and data, both national and international. Telecommunications play a very important role in supporting the smoothness of economic and government activities.

Indonesia's telecommunications services, both basic and non basic, have grown very rapidly and constitute a very important component of economic development. The role of telecommunications in national development is very evident (Parapak 1995): bringing to reality a greater sense of nationalistic awareness; strengthening unity: activating the smoothness of economic and government activities; opening up isolated areas; developing the intellectual life of the Indonesian national broadcasting; educating and supporting defense efforts and state security.

Just one example of Indonesia's utilization and application of technological development is the pioneering success of the domestic satellite communications system with the Palapa satellites.

Telecommunications development in Indonesia has experienced rapid success during the new order era. By the end of the 60s, work had already begun in many areas, including the developing of a microwave telecommunications system, an international satellite telecommunication system and central telephone automation.

The beginning of the 70s were marked by the satellite era and the start of applied digital technology. Repelita IV and Repelita V (the fourth and the fifth Five-year Development Plans) were characterized by rapid development of the national telephone system. By the end of Repelita V, the total capacity of telephone lines in Indonesia had reached almost 3 million, an increase of nearly 2 million new lines. Whilst it is right to be proud of this rapid progress, when seen from the penetration aspect of 1.69 telephones per 100 inhabitants (1995), this is in fact amongst the lowest in the ASEAN region. Therefore the government has already extended its policy of accelerating telecommunications development during Repelita VI, with a minimum target of an extra 5 million telephone lines.

With the population of almost 200 million the total number of telephone lines provides for only limited development simply because the people are spread across 6,000 islands. The problem is particularly acute in the field of education and the delivery of education to remote communities.

Guidelines of State Policy from the general direction of telecommunications development in Indonesia are elaborated in State Law No 3, 1989 and Government Regulation No 8/1993. This means that development policy is a guarantee of telecommunications operations, and also demonstrates that telecommunications is a vital and strategic part of national development (Parapak, 1995). Therefore, with state operational control through the state-controlled corporation as set forth in State Law No 3, there will still continue to be a monopoly on control of basic services, but non-basic services (value added) have been opened to the private sector. It must be realized, however, that the nation, through the state-controlled corporation, will not be able to meet all the needs of the public on its own. Therefore, there is the possibility of private sector participation and cooperation with state-controlled corporation in the operation of basic services.

In order to be able to offer a wide range of services and increased quality, the supply of terminal equipment will also be opened to private sector participation. Private sector involvement is allowed under Ministerial Instruction 39/1993, where co-operation with state-controlled corporations is permitted through joint ventures, operational cooperation and management contracts. The policy application mentioned above for Repilita VI consists in full of the following:

a. Development of 2 million new telephone lines through KSO (joint operation scheme).

b Development of a cellular telephone system through joint ventures.
c. Full private sector participation in the operation of public telephones and telecommunications outlets.

d. The operation of Palapa domestic satellite communications system through joint venture.

e. Private sector participation as soon as possible in paging systems, radio trunking, and value added services (Parapak, 1995).

The trend of Domestic Telecommunication Services in Indonesia 1992-1999:

1992	1993	1994	1995*	1999*	
Lines in service (million)	1,548	1,863	2,462	3,291	8,000
Population (million)	183	186	189	192	208
Penetration (phone/100 people)	0.83	0.99	1.28	1.69	3.84
GDP per capita (US$)	622	711	874	935	1,117
Number of public phones (000)	46,0	58,0	81,2	108,257	240,0

* Estimate

Figure 1
INDONESIA, 1995

Source: TELKOM,

The table (Figure 1) shows that by any standard, Indonesia's telecommunications network is a modern one. Moreover, it grows with a compound annual growth rate, from 1990 to 1994 of 24%. Notwithstanding, the 1995 telephone density was only about 1.69 per hundred persons as against the world average of 10 per hundred persons. It was also lower than that of many developing countries of Asia like China (1.7), Pakistan (2), Malaysia (13) (Conference Background Note, 1996).

UT and ECU

Universitas Terbuka

Universitas Terbuka (UT) is a public university, established in September 1984 to fulfill several aims, namely:

a. to provide higher education for high school graduates

b to provide "in-service training" for primary and secondary teachers.

As a national university, UT has to provide services for students throughout Indonesia, those residing in cities as well as in the remotest parts of the country. To deliver the services, thirty-two regional centers were established in major cities of Indonesia. The number of enrolled students is 398,315 (1996).

Course programs are developed by four faculties, Faculty of Mathematics and Natural Sciences, Faculty of Social and Political Sciences, Faculty of Economics and Faculty of Education. A study program worth 140 credits per semester consists of forty-six courses and covers a period of four - five years. Printed material is the main medium of instruction, designed to be self-contained and self-instructional. Currently UT has developed more than 600 courses. Educational radio broadcasting is also used regularly at local level. Some language courses are usually supplemented with audio-cassettes. Some other courses use audio-cassettes for enrichment. Video programs are mostly used for tutorials to be nationally broadcast by the national television channel. The use of computer assisted instruction and internet have been considered; currently still at the development stage.

Universitas Terbuka was established to meet several urgent requirements.

a. to increase the admission capacity of post-secondary education as an alternative to accommodate the fresh high school graduates not accepted at other state universities.

b. to provide education available for adult groups, those intellectually capable who need to upgrade skill and knowledge, and

c. to increase the quality of basic education by raising the level of pre-service education and training for teachers and providing classroom-based, in service training and regular pedagogical supervision especially in language (bahasa), math and science.

UT is the forty-fifth State University in Indonesia, introducing a non-conventional model of education and applying an open policy in the admission system. In conducting the teaching learning process, UT operates a distance system by using media kits (modules) designed for individual learning (Statuta UT, 1992).

After twelve years operating, it is clear that UT is far from satisfactory, not all of the expectations from UT can be fulfilled. Some data and problems can be identified as follows:

a. Total students: 398.315 (1996)

b Gender:

- Male 70%
- Female 30%

c. Employment status:

- 79% employed
- 21% unemployed

d. The input of UT is:

- 81% from high school students.
- 15% from diploma students
- 4$ from university degree students

e. The composition of media is as follows:

- 99.9% printed media.
- 0.1% radio and TV broadcasting

f. Most of the students come from urban areas; furthermore most of them come from Java, just one part of the country

g. Most of the students are groups of employees from private or government run institutions who enroll for a number of reasons e.g. company policy and funding (special tutorial classes, scholarships and many others). (Kadarko, 1995):

h. The tutorial attendance conducted by UT as part of the Students Service Center in each regional center is low.

Edith Cowan University

Edith Cowan University (ECU) is situated in Perth, a city of 1.3 million people in Western Australia. The nearest neighbour to the east is Adelaide (2,120km), followed by Sydney (3,284km). North is Jakarta (3,295km), Singapore (3,909km), and Bangkok (5,354km).

Edith Cowan University is now a university of some 20,000 students including 1,600 international students drawn from 58 countries. In addition it caters for 12,000 students in short customized courses each year. It has six faculties; Arts, Business; Education; Health and Human Sciences; Science, Technology and Engineering; and Performing Arts.

A range of New Learning Technologies is evolving with impressive speed: so much so that the technology is well ahead of the human capacity to fully utilise its capabilities. This same technology is greatly affecting interaction between staff and students worldwide.

New learning technology developments at ECU are best summarized as follows:

- Approximately 4,000 students now choose to study in external mode. They may do so from anywhere in Western Australia, Australia, and offshore.
- An increasing number of students are choosing to mix on-campus and off-campus learning. These mix and match options now attract 1,200 students, working from home, business or on campus.
- Faculties remain responsible for delivering the academic content of courses, but the central university infrastructure provides a University Learning System Division, to focus efforts, and encourage greater use of information technology.
- ECU possesses its own fully equipped three camera television production studio with field capabilities, and creates its own educational productions. These are fed into a regional television network, as well as the SSB National Television Universities Consortium, of which ECU is part. It has capabilities of transmitting or receiving anywhere by satellite.

- ECU campuses are linked by optical fiber or microwave facilities, with provision for live lectures on any one campus to be simultaneously delivered on other campuses, or anywhere in the world. Interactive facilities are provided for two-way visual and voice communication between students on any campus and the lecturer concerned. This full bandwidth interactive television link (ECUNet) has been operating since 1991.
- Computer learning technology is widely used, both on and off-campus. This facility, known as Virtual Campus, provides the technical means by which real time interactive contact is made using computers; between students and staff, students to students in tutorial settings, and delivery of material. Feedback suggests that this learning facility has done much to overcome feelings of isolation. There is no limit on the bounds of Virtual Campus, which operates Australia-wide and internationally.
- Several millions of dollars have been invested in Computing Laboratories, Resource Based Learning, and Web servers to support flexible delivery. Electronic mail is widely used.
- ECU led a consortium which won one of the first two national Collaborative Multimedia Centre grants from the Australian Government to further the development of the interactive multimedia industry. This university-industry consortium is now operating under the name IMAGO. A Centre for Virtual Environments is currently under study as one outcome.

Interactive Media

Characteristics of Interactive Media: Interactivity

All of the new communication systems have at least a certain degree of interactivity, something like a two-person, face-to-face conversation. New interactive communication systems (usually containing a computer as one component) enable "talk back", almost like an individual participating in a conversation. The new media are interactive in a way that the older, one-to-many mass media could not be, potentially reaching many more individuals than if they were just face-to-face. In effect, their interactivity makes them more like interpersonal interaction. So the new media combine certain features of both mass media and interpersonal channels.

Interactivity is a desired quality of communication systems because such communication behavior is expected to be more accurate, more effective, and more satisfying to the participants in a communication process. These advantages usually come at the cost of more communication message exchanges and the greater time and effort required for the communication process (Rafaieli, 1984).

So the most distinctive single quality of the new media is their interactivity; their basic change in the directionality of communication from the one-way, one-to-many flow of the print and electronic mass media of the past century. Put differently, in interactive communication systems the individual is active rather than completely passive or reactive.

In UT history, several interactive media have been used for UT staff and students services since 1986, as follows:

1. Single side band (SSB) simple radio (two way) communication and oral tutorial between UT regional centre and learning centre (1986-1988).

2. Audio Conferencing through Palapa Satellite

The point to point audio conferencing (under PT. TELKOM) have been used for several years to bridge the islands to solve communication and tutorial problems.

3. Rural Satellite Project

Under supervision of Directorate General of Higher Education and USAID Washington, UT participated in a Rural Satellite Project with eleven other public universities in the eastern islands of Indonesia. There were three components of media, printed through fax, graphics (teleblackboard) an audio conferencing.

4. COSY (Conference Systems)

Under CIDA and University of Guelph sponsorship, UT joined computer teleconferencing with seven other public universities in Indonesia, the so called SHARE Project (Project Satellite for Health and Rural Education). UT staff benefited from this project in using email and computer teleconferencing with Canadian universities in Toronto, Vancouver and Guelph.

5. SIKKO

PT Indosat (Indonesian Satellite Corporation) offered computer teleconferencing for UT and six public universities as continuation of project SHARE.

The Internet as a Cost-Effective Mode of Interactive Delivery

Keegan (1986) characterized distance education as:

a) The separation of teacher and learner throughout the length of the learning process.

b) The influence of an educational organization in the planning and preparation of learning materials and in the provision of student support services.

c) The use of media for delivery of learning content.

d) The provision of two-way communication.

e) The absence of the learning group so that people are usually taught as individuals and not in groups. Face-to-face meetings between students and tutors may occur occasionally.

Research conducted by the Open University of Indonesia (Djalil 1995) indicates that many of the students cannot attend the face-to-face tutorial meetings due to lack of time, lack of transportation, and due to the distance of the tutorial location which is too far from their homes to reach. Thus many of the students who need assistance in the process of learning cannot afford attending the tutorial meeting.

Face-to-face tutorials are very dependent on time, place and other resources. At UT it is very difficult to arrange times which are convenient for both the students and the tutors. In many cases schedules are determined by the time available for the tutor and the majority of the students. It may be helpful if there are other ways to enable distance education students to communicate with tutors and the organization. email for example, is very useful for tutorials in distance education.

Home Page

UT has started developing a Home Page (http://www.ut.ac.id) though the technology is still at an early stage. Students and the public have access to the home page to find general information about UT. However, the ability of UT students to read other Home Pages from foreign countries is very limited due to the English language problem.

Virtually unknown in Indonesia until early last year, the Internet has now made a convincing presence. Less than a year after the first license had been issued, today more than twenty-five permits have been granted to ISP (Internet Service Providers). Subscribers to the five ISPs who are now in operation are over 60,000 and are growing (MASTEL, 1996). Most of them are young bright and well-educated.

Although there are still questions to be resolved involving security and bandwidth, Internet seems to become the "killer application" of IT in Indonesia and elsewhere. The number of public institutions as well as private companies who have a presence on the Web is growing. Ministries of Health, Industry and Public Works, the Indonesian Institute of Sciences, Jakarta

Metropolitan Government, Bureau of statistics, universities and all leading newspaper and magazines have a home page on the Net. Recently the Indonesian yellow pages (telephone directory) with advertisements and hyper-links is joining the entities who exploit a business use of the Net.

Multimedia Education Project

The scene is set therefore in Indonesia and Australia for a substantial re-think of distance education (Renner, 1995 and 1996). The internet and interactive multimedia delivery on the Web offer new opportunities for rural and remote students to receive a university education little different in quality from on-campus programs. Both UT and ECU are currently planning a co-operative approach to distance delivery using multimedia and Web technologies to improve the quality of off-campus learning.

The objective of this international project is to develop an educational industry, based on the production of interactive multimedia courseware to serve the educational needs of UT and ECU. Not only will multimedia delivery enhance student learning, its production within the participating universities will promote skill development among staff and senior students and enable the universities to market multimedia packages nationally and internationally.

The project builds on a succession of successful pilot initiatives by Edith Cowan University in Malaysia, Thailand, and more recently, Indonesia combining the communication engineering strengths at Edith Cowan University (very fast processing and compression protocols) and information science expertise (e.g. instructional design for multimedia, IMM development methodologies, IMM screen and interface design) to generate exportable software in user friendly format and to enhance the levels of skill in multimedia engineering, multimedia production and multimedia use in Indonesia and Australia. Consideration will be given to the network and platform capabilities of users and to skill development amongst key contributors in Indonesia. In addition, quality control procedures already piloted in Thailand and Australia will ensure content validity and appropriate presentation standards.

INPUTS	OUTPUTS	ACTIVITIES
• Virtual Campus Technology and the development of very fast communication systems (ECU).	• Training programs for local and rural students	• Workshops to train multimedia technicians, multimedia engineers and multimedia managers in Indonesia.

• Multimedia production skills (ECU/UT).	• Multimedia modules for use on campus and for rural communities	• Production of multimedia modules designed for technical/skills development industry needs and university education. Trialling of modules in various environments e.g. on campus and in rural communities.
• Multimedia production teams located at Edith Cowan University and Universitas Terbuka	• Market appraisals and recommended actions from Indonesia and Australia based on market sampling and student feedback.	• Commercialisation, development and confirmation of inter-organizational links/infrastructures. Clarification of commercial responsibilities. Market sampling and feedback from students.
• Universitas Terbuka Affiliated Centres/Outposts		

Figure 2 Multimedia education project: structural- sequential plan

More specifically, this multimedia education project will:

- Enhance the quality and effectiveness of electronic delivery in Indonesia and Australia by providing multimedia modules for use in a wide range of educational settings.
- Develop a strong skill-base within and between the participating countries to ensure on-going productivity by the development and sharing of skills in project teams.
- Deliver interactive courseware into urban, rural and remote locations to enhance educational delivery and skills in those communities using existing and projected communication networks.
- Extend entrepreneurial activity to other countries for commercial benefit through nominated commercial counterparts.
- Strengthen existing co-operative arrangements nationally and internationally resulting in (i) staff and student exchanges, (ii) sharing of multimedia products and skills, and (iii) positive national and international relationships.
- Use planned multimedia development and production to develop job skills, create jobs and increase educational opportunities in Indonesia and Australia.

Conclusion

Interactive media innovations, such as telephone-based teleconferencing and computer conferencing systems have successfully supported education in the United States, Australia, Canada and Europe. The Rural Satellite Program Projects in Indonesia have demonstrated that teleconferencing is an efficient and effective means of delivering training and instruction over vast distances to isolated and remote audiences in order to create high human touch as an enhancement to one-way media.

In general, interactive multimedia is an effective and successful way to deliver education and training, when, according to Tietjen (1987):

- The instruction is relatively specialized and not easily accessible.
- The number of learners is somewhat limited.

- Interaction is important to the learning process.
- The students are motivated and are experienced learners.
- Face-to-face instruction is either impossible, or of low quality or too expensive.
- Highly skilled teachers are not readily available locally.

Higher education is the area in which multimedia technology has made the most significant advances as an instructional support tool. Interactive media such as telephone-based or teleconferencing systems and email allow for two-way communications, question and answer sessions, discussion and immediate responses to learner needs.

While print media still dominate, the importance and necessity of using a variety of interactive media formats is increasingly recognized to meet a range of functions, particularly those requiring interactivity. The experiments, demonstrations, and pilot projects using the interactive media mentioned above represent a practical, experimental approach to determine the most efficient means of serving university students. Interactive media approaches also solve another very practical problem. They provide an immediate solution to many of the usual pressing problems facing many educational institutions in Indonesia, such as lack of qualified teachers in rural areas, and the lack of student's time in urban areas. Yet it should be emphasized that at this time interactive media are complementing the older media in education, not replacing them.

It seems obvious that the information challenge in the future will be to utilise the interactive media to solve problems of communication in universities akin to the Open University. However, if the low use of interactive media is mainly caused by the relatively high cost, the new question is "can interactive media provide improved quality of communication at a lower price?" We, the authors, remain optimistic that the internet will continue to offer cost effective interactive opportunities to enable UT and ECU, among many universities world wide, to solve their special communication problems.

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INSTRUCTIONAL AUDIO TELECONFERENCING:
Strategies for Encouraging Faculty to Teach by Telephone

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1. ABSTRACT

This presentation will describe the development of a telecommunicated distance education(TDE) project that utilizes interactive television (one-way video, two-way audio), audio teleconferencing, voice mail, e-mail and FAX to deliver instruction. Special emphasis will be given to strategies for attracting faculty participation and to issues related to the role of telecommunicated distance education (TDE) in higher education.

2. OVERVIEW

The delivery of quality education to children with disabilities in the United States is a significant challenge. There is no single component that will assure educational excellence, but certainly a well-trained and willing staff must be considered a fundamental requisite. TDE is by no means a new instructional technology. However, while business and industry have invested millions of dollars annually to take advantage of the time- and cost-effective benefits of teleconferencing, there have been limited efforts by institutions of higher education to explore the potential of instructional teleconferencing. The information revolution can make current knowledge obsolete in a matter of a very short time. The information explosion and tighter budgets have made it necessary for university administrators and faculty to rethink traditional attitudes and approaches toward undergraduate/graduate and continuing education (CE).

In addressing the issue of encouraging faculty to become involved in teaching TDE classes, a chronology of the author's experience in TDE may be helpful. During the ten years preceding the implementation of this audio teleconferencing project, the author had been utilizing the Indiana Higher Education Telecommunication System (IHETS) to produce multi-point interactive television graduate courses and ad hoc special topic video teleconferences to personnel serving children with speech, language and hearing disorders. This activity continues to date. While the IHETS one-way video, two-way audio television network is very good and the telecasts are well received, there were and still are problems.

(1) In the early years, the only IHETS reception sites for telecourse offerings were on state university campuses. Consequently, there were large areas of the state where students were too far from reception sites to participate. However, recently that situation has changed. Public schools, hospitals, and private universities are now permitted to connect to the IHETS, and a significant number have chosen to do so.

(2) On most campuses there are no classrooms dedicated exclusively for TDE. Often, after space needs are met for on-campus students, no rooms are available for TDE, or they become available too late to organize a telecourse.

(3) As the demand for TDE increases, IHETS television network and studio time becomes more difficult to obtain. There is no charge for using the IHETS television network. However, studio production and reception site costs, while reasonable, are significantly expensive.

In working with telecourse production, the author discovered that IHETS also had a toll-free state university voice network (SUVON) and a 40-port telephone conference bridge. Requests for using the bridge were limited. Teleconferencing was most often conducted for administrative purposes or press conferences with athletic coaches. SUVON had never been used to deliver TDE courses. The discovery of this seldom-used telephone network and its potential for addressing the problems mentioned above provided the impetus to explore teaching by telephone.

This paper describes an instructional audio teleconferencing project conceived and implemented by a university professor who was looking for an instructional model that would help close the information dissemination gap between higher education and distant learners. As a professional speech pathologist and audiologist, he had no formal training in TDE.

The project has been funded continuously for the past 17 years by the Indiana Department of Education, Division of Special Education. It was divided into two phases. The goal of Phase I was to enable local education agencies (LEAs) to independently develop staff TDE programs, establish audio teleconference rooms in all Indiana LEA special education programs, and provide funding and training. The goal of Phase II was to assist the faculty at the four Indiana state university special education training programs to utilize the network of public school teleconferencing rooms to deliver credit telecourses and non-credit CE. Phase I was a necessary foundation upon which Phase II was implemented because it provided the TDE receive sites the universities would utilize when offering point to multi-point TDE.

3. PHASE I

In 1975, the United States Congress passed Public Law 94-142, which required public schools to educate all handicapped children. Prior to passage of this monumental legislation, children could be denied services at the discretion of the LEA. In response to concerns about teacher competency in educating children with special needs, P.L. 94-142 mandated that LEAs implement a comprehensive system of personnel development (CSPD). At the state level, the Indiana Department of Education revised teacher certification, eliminating the life license and requiring periodic renewal. Teachers working in the state must participate in 190 contact hours of approved CE every five years in order to renew their licenses. Continuing education has become a fact of life. No longer left to individual discretion, CE has become the responsibility of employer and employee alike. Higher education and both federal and state agencies must also be active participants.

Continuing education has traditionally been delivered through face-to-face meetings of one kind or another. Since human beings seek and enjoy personal interaction with colleagues, this approach will remain the preferred choice. However, it has become very clear that there is neither enough time nor money available to keep pace with the rapidly expanding knowledge base if we are limited to the traditional face-to-face approach. We must continue developing alternative CE models that disseminate information in a manner that minimizes the time and money the learner must invest to be able to participate.

3.1 ORGANIZATIONAL PLAN

The three-year organizational plan for Phase I was as follows:

(1979-1980):

Speech-language-hearing clinicians in 16 participating LEAs were each provided with funding for 10 hours of TDE. During this initial period 1,700 contact hours of instruction were delivered.

(1980-1981):

Thirty-one additional LEAs were added. Speech-language-hearing clinicians and special education personnel employed by 47 LEAs were provided 470 TDE hours. During this period 6,400 contact hours of instruction were delivered.

(1981-1982):

The remaining 17 Indiana special education programs joined the 47 continuing programs. The format remained the same with all 64 LEAs entitled to 10 TDE hours. During this initial period 9,120 contact hours of instruction were delivered.

The director of special education for each participating LEA appointed a TDE planning committee. This committee worked with the project director and the selected consultant(s) in planning and evaluating teleconferences.

As new programs were asked to participate, the LEA site coordinators and their directors were invited to Purdue to receive their speaker telephones and to participate in an orientation/training conference. The project director prepared a TDE training manual for participants from each LEA. Each participating LEA was provided a Darome, Mini-Convener, Model 610-A.

They returned home to select a suitable room in which a modular telephone jack could be installed on an existing telephone line. The committee, after consulting with colleagues and the director, recommended the content and format of instruction based on identified local needs.

The 64 LEA planning committees selected speakers/consultants from throughout the continental United States. All consultants were chosen on the basis of their recognized expertise, and their speaking/teaching skills. The instructional format was flexible to provide maximum adaptability to individual LEA staff needs. Initially consultants were paid $50 per on-phone hour of instruction. While $50 was certainly a minimal fee, very few consultants declined invitations to present. Each LEA coordinator was given a credit card number to use for project-related phone calls.

The project director compiled a resource directory of consultants who had agreed to participate in the project. A copy of the directory was given to each LEA site coordinator. The directory included addresses, phone numbers and areas of expertise of 335 persons from throughout the United States. Planning committees were not limited to selecting consultants from the directory.

Before a teleconference the consultant mailed one copy of any handout materials, his/her picture and a resume to the LEA coordinator. The consultant's audio and/or visual aids were also mailed in advance of the conference call. The site coordinator had the materials copied in sufficient quantity for distribution to the participants. The site coordinator also sent the consultant a picture of the participants along with their names, educational specialties and types of children served.

3.2 Evaluation

Evaluations were conducted throughout the project. The participants, site coordinator, and consultant completed evaluations after each speaker telephone session. The completed evaluation forms and narrative comments were sent to Purdue University for processing. Item analysis data were returned to the LEA coordinator and the consultant for their information. At the conclusion of Phase I all evaluations were subjected to item analysis.

Phase I evaluation data revealed that the project provided 6,400 contact hours of instruction. This is particularly significant in view of the fact that 37 per cent of the participants reported having had no CE hours in the year preceding the project. Participant evaluations (2,438) strongly supported audio teleconferencing as a viable alternative training model.

The responses to two questions from the participant evaluations were of particular interest. (1) Seventy-eight per cent of the participants agreed that they were able to relate the information acquired to their clinical/instructional needs. (2) Eighty-seven per cent of those surveyed agreed that the speaker telephone project was "excellent."

Strategies for enhancing participant interaction with consultants and strategies for providing consultants with more effective feedback during the teleconferences needed continued development and consideration.

Participants also identified occasional problems with the telecommunication system. Extraneous line noise and/or weak line signal had a negative impact on some teleconferences. The solution to the problems seemed more related to the state-of-the-art in telephone technology rather than changes within the project. However, LEA site coordinators were trained to deal with system problems when they occurred, and the reported problems did not seem to dampen the enthusiasm of the participants.

Item analysis of the evaluations completed by TDE consultants revealed two significant points. (1) Eighty-three per cent of the consultants agreed that their sessions were "excellent." (2) Eighty-two per cent agreed they would be interested in continuing as a TDE consultant.

Ninety-four per cent of the consultants had no prior telephone teaching experience and initially expressed considerable apprehension about providing instruction to persons they could not see. Only once did a consultant withdraw from the project after his first session--this inspite of positive participant evaluation. The consultants' final evaluation data reflected a very positive attitude toward TDE and the success of their efforts.

Participants preferred TDE sessions during or immediately after school. Evening and Saturday sessions had the poorest attendance.

While participant evaluation data were very positive, it is important to examine the project in terms of cost effectiveness. A record was kept of the distance each consultant would have had to travel to deliver the information face-to-face. During the three years in which Phase I was implemented, 282 participating consultants would have had to travel 519,948 miles to deliver 991 hours of instruction. Actual telephone toll charges were compared with the travel costs (excluding food and lodging) that would have been required for a face-to-face meeting. TDE in this project resulted in approximately a 55 per cent savings over information delivered via traditional face-to-face model. Food and lodging is a major cost for the delivery of face-to-face instruction. Had that data been factored in, the cost savings would have been significantly greater.

The true measure of success of this TDE project was the willingness of the participating LEAs to continue the project without supplemental funding. Each LEA was informed that it could keep the teleconferencing equipment if it would provide staff with a minimum of five hours of TDE per year for the next three years. The cost of this commitment represents the approximate cost of the conference telephone. Of the 64 participating LEAs, 62 chose to continue providing TDE to program staff.

4. PHASE II

The goal of Phase II was to assist the faculty in utilizing the network of public school teleconference rooms to teleteach. Course participants could take a telecourse for credit (exams/grade) or audit (no-exams/continuing education units only). This phase of the project is now in its fourteenth year, and we have developed some effective strategies for getting faculty involved in TDE.

In talking with faculty, five concerns were most often expressed. They were, (1) apprehension about a teaching model so very different from traditional face-to-face instruction, (2) skepticism as to whether a quality course could be taught by telephone, (3) time commitment would be in addition to their regular faculty assignments, (4) compensation, and (5) the department head's attitude about faculty involvement.

4.1 APPREHENSION

The strategy found most effective in dealing with faculty apprehension about teaching by telephone was to initially focus on attracting faculty that were recognized as excellent teachers. Faculty confident in their teaching skills were much less apprehensive. They became excellent role models and TDE advocates in attracting other faculty. The project director invited selected faculty to attend, expenses paid, distance education conferences and gave them appropriate material taken from publications and the world wide web.

Providing faculty with opportunities to experience TDE happened gradually. One strategy was to invite an individual who had not yet been involved as a guest lecturer for a telecourse being taught by another instructor. Another strategy was to invite these individuals to present 90-minute ad hoc teleconferences for practicing professionals in the state. Hands-on experience proved to be the single most effective approach to enlisting faculty participation. As with the consultants in Phase I, we could see a positive change in their feelings about TDE.

4.2 SKEPTICISM ABOUT QUALITY

Over the years, distance education literature has reported a rather pervasive attitude by university administrators and faculty, that TDE provided a second-rate education. Those attitudes are changing as more and more research studies support the efficacy of TDE. The supporting information gleaned from research is distributed to all administrators and faculty regardless of their direct participation in TDE. It is made very clear to participating faculty that, like traditional teaching, they set the standards for their own telecourses. They are encouraged to maintain high quality standards for their TDE courses.

Significant concerns expressed by faculty are, "How do I get to know the course participants? How do we effectively interact? How do I get feedback?" Insight gained from this project suggests that TDE students may in fact, have more interaction with their instructors than students in the traditional model. See discussion under Time Commitment below.

4.3 TIME COMMITMENT

This concern is addressed in a very straight forward manner. Yes, teaching these courses will be demanding and will take time. Because it is demanding, faculty are given the support needed. Faculty support is absolutely critical to the on-going success of any TDE effort.

The project director, assisted by Purdue's Continuing Education Administration, assumes responsibility for all administrative and technical aspects of the course. This frees the instructor to focus on course content, teaching strategies, and student interaction. A graduate student assistant is assigned to assist the instructor in preparing course materials, grading assignments, and other designated duties. The instructor, graduate assistant, and the project direct meet well in advance of the starting date to discuss course organization and management. The instructor is given printed material describing a variety of techniques designed for effective telephone teaching.

The instructor has office hours so that students may call to speak directly with him/her. Telecommunication technology has made dialogue between teacher and learner free of time and place. The instructor and course participants use toll-free voice mail, e-mail and FAX to communicate between class sessions. Should a student have a need or question any hour of the day, s/he may use voice mail or e-mail. Students without their own voice mail are provided with toll-free VM boxes. FAX is used most often to submit written assignments and documents. The graduate assistant participates in these communications whenever the instructor deems appropriate.

Other support personnel involved are the site coordinator and examination proctor. Criteria for selection of a site coordinator include: being registered for audit of the course, leadership qualities and interest. The site coordinator distributes materials to students, takes attendance and provides the instructor feedback after each class session. S/he does not proctor examinations. Someone not taking the course is selected as proctor. Most often the proctor is recommended by a local administrator at the participating reception site.

4.4 COMPENSATION

When faculty are asked to assume overload teaching responsibilities, they need to be rewarded for their efforts. Some TDE programs provide released time from teaching assignments for participating faculty. As desirable as released time may be, that was not an option for this project.

Telecourse instructors were offered an honorarium. Payment is negotiable with a firm payment guaranteed if the telecourse has sufficient enrollment. Additional compensation can be earned based on enrollment over a predetermined number. This payment strategy has been successful in helping attract telecourse instructors. However, faculty voiced concern about tax implications. In response to this concern, an alternative option was added. The honorarium could be placed in a university account designated for use by the instructor's department. The telecourse instructor could draw on that account to the limit of the honorarium. All expenditures had to be related to university business. This option proved to be the most popular, with the money most often used for travel to professional meetings.

4.5 ADMINISTRATIVE ATTITUDES AND SUPPORT

University administrators, while supportive of serving distant learners, must consider the overall needs of their academic units. What benefits are there for the department? What impact can TDE have on the department's teaching and research mission?

As this project evolved over the years, many benefits beyond making an important contribution to citizens at large has become apparent. More students are being served without any increased demand on the university's physical plant. No more classrooms, residence halls, food service, or health care facilities are required. Just a single room, often a classroom, with on-campus students participating as well, is needed. If there is no on-campus student enrollment, then the instructor, wearing a headset, can teach from his/her office with no additional space requirements.

There is a cost-sharing benefit. Should registration fees from a multi-point telecourse exceed expenses, a percentage of those excess funds are transferred to the department's account.

Teaching by telephone is not limited to disseminating information off-campus. It can be utilized to strengthen the department's curriculum. The information age has made it virtually impossible for any academic program to have faculty with expertise in all the areas vital to student training. Training programs are enabled to invite nationally recognized and skilled professionals to teleteach specialized courses to students-in-training. These distinguished professionals, who could not come to campus even if funds were available, enthusiastically accept the challenge of sharing their knowledge and experience. For many years this TDE project has been able to offer students telecourses taught by adjunct professionals. By making these telecourses available to practicing professionals at reception sites throughout the state, the off-campus registration fees usually are sufficient to cover all the course expenses. This is a significant benefit to department administrators who are being asked to do more with less.

Attitudes toward TDE are changing. Governmental funding agencies, education, and business are all actively encouraging development of TDE potential. Research grant proposals which include a TDE dissemination component may have a positive impact on reviewers' evaluations. In fact, a Purdue department faculty member submitted a grant proposal to a federal agency requesting funding for a research project that included critical funding for graduate assistanceships. The proposal got favorable reviews but was not funded. The grant proposal was resubmitted again the following year. The only change made was to add a TDE plan to the dissemination section. The proposal was funded. Since that time two additional research grant proposals which included a TDE plan have been funded.

5. CONCLUSION

Technological advances in telecommunication have resulted in a variety of options for teaching distant learners. University and college faculty must be encouraged to explore the application of these options in meeting the educational needs of students and practicing professionals. Cutting-edge integrated computer and television technology is very exciting and receives a great deal of attention in the media. However, it will be many years before this technology is fully integrated into education and society as a whole. Conversely, the telephone is well integrated into our culture. Most everyone has one. It can, more then any other technology, make it possible for people to communicate. When Western Electric experts evaluated Edison's telephone, they described it as an interesting device, but could see no practical value to the instrument. We must not make the same mistake and overlook the potential of teaching by telephone.

THE COMING OF THE VIRTUAL COLLEGE

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ABSTRACT

The Internet is promoting strong collegial links between individuals with the same academic interests who are in different universities. This contrasts with on campus links between academics in different departments where the subject of discourse is more likely to be associated with social activities and common problems of administration.

Developments in using the Internet at Victoria University of Wellington's Department of Communication Studies suggest the growth of virtual colleges made up of departments in a specific subject area from many universities and many countries. This could give rise to virtual colleges of communication studies, anthropology, business studies, etc. which would be characterised by subject homogeneity and an international approach to teaching. This would contrast to the activity of place-based universities offering heterogenous combinations of subjects in a local context.

Some 10 years ago Dr Lalita Rajasingham and I began an action research programme at Victoria University of Wellington in New Zealand that addressed the question "What kind of education system is needed for an information society?". Action research has a cyclical pattern to it whereby the researchers make repeated attempts to achieve an objective, learning from their mistakes and reflecting on the nature of their objectives. We are about to embark on our fifth cycle and do not imagine the information society has arrived or that we have discovered what kind of education system it needs. Hence the title of our research programme: "The Search for the Virtual Class (Tiffin and Rajasingham,1995) What I want to report on in this paper is some of the more interesting outcomes of our fourth cycle of research which ran from July 1995 to Oct 1996 in particular the signs we saw of the emergence of a Virtual College.

The essence of a Virtual College, Virtual University or Virtual School is that the key elements that constitute education (teachers, learners, knowledge and problems) can be brought together by telecommunications rather than by transport systems. Our research assumed that an information society would have an infrastructure of information technology that would see broadband telecommunications universally accessible (Negroponte 1995), the processing capability of computers increasingly miniaturised and pervasive (Drexler 1990) and interfacing with information technology increasingly symbiotic. One day in the next century we saw our great grandchildren or their children wearing information technology to go to school.

In the first three cycles of our research we used the plain old telephone system to provide email, access to databases and teleconferencing to bring together the critical components of a university programme. And we made it work, because we designed it and redesigned it and redesigned it and because we had the kind of support from The New Zealand Telecommunications Corporation and the Australian Telecommunications Corporation that made this possible. The New Zealand Telelearning Network perhaps the first national network of this kind is based on the design that emerged from this phase of our research.

In June 1995 we began our fourth cycle but this time we based it on the Internet. What we were doing was no different to what we had been doing in the previous seven years, but because we were doing it on the Internet the intervention was not as controlled as it had been in the past when we had used dedicated telecommunications systems designed by ourselves and supported by our national Telecom, with no expense spared to ensure that it worked. We were at the mercy of developments on the Internet and this was the period when the Internet hit the steep slope of expansion.

In July 1995 the basic reading for our courses was a university library. The Web provided interesting supplementary materials. Today there is no way our university library can match the resources of the Web. Our university library has become supplementary to the Web. This alone has vast implications for education. It is libraries which anchor the location of universities and preserve the form of their curricula. Keeping pace with the expansion of knowledge and maintaining collections by buying books and journals and building places to house them and for students to access them is one of the biggest single costs of a university. One of the questions that bedevils the introduction of any new programme of study is: 'What are the implications for the library?' The web is cutting academics and their students free from having to physically go to the library to get knowledge. The implications are that knowledge can be accessed from anywhere at any time.

We have found that it is not just that the Web has more information than our university library or that it is becoming an audio-visual as well as textual library, or that it is more convenient to use and a faster way of finding and accessing information. There is also a qualitative change in the way we are exploring and describing knowledge that comes with the way knowledge is networked on the Web. There is the ease with which students can pick up the threads that a teacher can provide to a subject on the Web. Of course, students can always follow up references in a conventional library, but we find that students in their turn do their assignments on the Web and provide threads that link their work to bodies of knowledge. In effect this means that their is an infinite number of ways in which their assignments can be read.

There are a lot of other teachers out there putting course outlines and materials on to the web and providing their own set of threads. We found our students were looking in on other courses in the same field. Since there is often an email address that allows a reader to link with the writer in cyberspace students and academics began chatting with each other. Subject associations which cater to the academics and grad students are springing up on the Internet. They are places of gossip about university practises in the subject area and a community that can help a despairing researcher or someone lost in an assignment. Herein are the seeds of collegiality for the growth of a virtual college.

The email component of our teaching programme also expanded. And continues to do so relentlessly. To take a few days break is to come back and discover a vast mass of accumulated mail. Dealing with email becomes a major part of the day's activity for academics and students. It is not just that this is a medium for assignments and course housekeeping and for students to chat, argue and debate. We find ourselves increasingly linking with specialists and fellow researchers and teachers in our field of interest. Our students are doing something similar. They are no longer confined to our campus and its teachers and students and activities. When we are with our colleagues in the staff room we talk about parking problems and campus politics. It is on the Internet that we find academic collegiality.

We wanted to keep the synchronous mode of the seminar but the hardest thing to achieve in teleconferencing is satisfactory sound such that all the people involved in the conference can hear clearly and can be heard. Good audioconferencing on conventional telecommunication systems is bad enough, but on the Internet it is worse. The Internet is not a truly synchronous system and there is a perceptible delay between the transmission and reception of voice messages and this is not conducive to the kind of discussion that one strives for in seminars. We managed. It can be done. This is a bit like saying that the early trans-oceanic telephone calls worked because despite all the attendant noise it was possible to hear enough of the words to understand the basic meaning of what was being said-most of the time. The down side was that group interaction was inhibited and had to be supplemented by telephone conferencing and face to face sessions. However, we get more adept, the available bandwidth improves and the enabling software is getting better.

The graphic systems we used proved reliable. Unfortunately, the capability of graphic systems grows in inverse ratio to the ease with which they can be used and we amassed a lot of design information on what teachers really want in graphics as distinct as from what computer programmers think they want. Given the low quality of the audio, the graphics were invaluable as a method of anchoring what was being discussed.

We began by video conferencing and still video all our seminars so that distant centres have a back up copy and there is a copy in the library for anybody who is unable to attend a seminar. However, we only go to video-conferencing mode now to introduce a new speaker or on the rare occasion that someone actually needs it to demonstrate something that involves vision with motion. Essentially we have found video conferencing a distracts and prefer to use the bandwidth involved to get better quality audio.

The links discovered on the Web and followed up on email introduced international guest speakers to our seminars. Each week in each of our courses we have had at least one international academic or specialist discussing their field with our students for approximately half an hour. It is this which has us wondering whether we are looking at something in the nature of an emerging virtual college. I use the term

"college" because this activity is based upon collegiality. By this I mean a willingness on the part of people who are at the front edge of knowledge to share in discussion and debate with like minded people in associated areas. At the moment this is done without regard to remuneration, although there is an understood quid pro quo and our academics in turn find themselves in taking part in other peoples seminars . So far we have primarily used the plain old telephone system, but recently we were delighted to find in a shared seminar with a group in Syracuse University that we were able to download to them the software they needed to join with us in an audio-graphic conference on the Internet.

One final dimension needs to be mentioned; that of virtual reality. From the inception of our action research programme we always imagined that one day the virtual class would be conducted in virtual reality and that this would subsume current teleconferencing activities. We have been privileged to have been associated with Professor Nobuyoshi Terashima in his work in developing Hyper Reality technology which at some point in the early part of the next century will make such ideas possible. What fascinates us at the moment, however, is the emergence of such virtual worlds as "World Chat" and "Alpha World". We have used these worlds to stage meetings as avatars. For example, David Goebels, President of World Inc. in giving a paper to our students on the telephone presented himself simultaneously as an avatar in "Alpha World" so that he could show us his ideas for extended reality. One implication of this is that we can begin to think of disconnecting the virtual class from the virtual classroom. We still tend to be locked into the old paradigm of education and the idea that the place where the components of education come together is a room. What this new dimension suggests is that it can be any place that our imaginations or telesensors can reach.

In February 1997 we begin the fifth cycle of our action research programme in 10 years. We intend now to move each cycle further and further into virtual reality and wonder where the next ten years will take us.

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Technology Trends and Their Influence on the Role of Satellites in the GII

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1. ABSTRACT

Examining trends of information technology components in terms of their maturity can provide insights on points where implementations of technology will yield viable market applications of the GII. The information technology components examined are computers, software/applications, network protocols, and transmission systems (both long distance and local). These technologies are at varying degrees of maturation from the standpoints of performance ceiling, cost, and integrators' acceptance. The matrix of components and their maturation, although crude in its resolution, will provide context for formulating positions on the role of satellites in the GII.

2. INTRODUCTION

Information technology components comprise the structure of the GII. Even though the applications of the GII have not been fully defined, rapid improvements in these technologies have provided policy makers the impetus to nurture the perceived benefits that a sophisticated global communications network will deliver. Under the framework of the Open Data Network, policy makers hope to create a level playing field that will ultimately benefit the consumers (1).

Examining trends of information technology components in terms of their maturity can provide insights on points where implementations of technology will yield viable market applications of the GII. The information technology components examined are computers, software/applications, network protocols, and transmission systems (both long distance and local). These technologies are at varying degrees of maturation from the standpoints of performance ceiling, cost, and integrators' acceptance. The matrix of components and their maturation, although crude in its resolution, will provide context for formulating positions on the role of satellites in the GII.

Satellite technology is arguably the least mature of the discussed components but potentially the most influential of them in its capacity to shape the emerging GII. The migration of satellite usage from the current solitary geo-synchronous platforms to the numerous proposed integrated low earth orbit systems is evidence not only of satellite's relative immaturity as a technology but also its capacity to inspire the imagination of communication service providers.

A conceptual framework describing the development of technology is presented and is used in the subsequent analysis of the selected technologies.

3. A FRAMEWORK FOR ANALYSIS

3.1. SCOPE OF FRAMEWORK

An issue among economists, technologists, and futurologists is what are the factors that govern the development and acceptance of new technologies into society. Although no widely accepted model describing the factors and their interaction exists at this time this paper presents a framework for such a model.

The model of technology development defines technology and then describes its developmental cycle and the factors influencing this cycle. Using this model as a basis it is then possible to describe the chosen technologies and their interaction.

3.2. TECHNOLOGY DEFINED

The term "technology" is a social construct created to embody the characteristics associated with production of any particular product consumed by society. In this paper, products and services are considered to be equivalent. Commonly, the term technology is used to group the capabilities used to manipulate a particular set of features associated with a product. For convenience this particular set of features will be referred to as a feature set. There can be more than one technology and its associated feature set attached to a product. Restated, the definition of technology is: "The set of capabilities used by society to manipulate a particular feature set associated with a product."

An example of a technology is the distribution of electric power. As is the case with most technologies it can be subdivided into a number of constituent technologies such as power generation, transformer design, conductor and insulator manufacture, and metering. The summation of these technologies, electric power distribution, is associated with a particular product as is each of the constituent technologies. Each of the constituent technologies and its summation has a feature set associated with it that is dependent on the scope of the technologies' definition

Society perceives that technology matures over time. This stems from observations that over time technology is able to produce the feature set of a particular product at lower cost and/or higher performance. A recent NASA Contractor Report (2) expanded on a talk by John Walker ofAutodesk and provided the following description of the maturation process:

> "... for a given technology, the rate of improvement is actually not exponential. The true curve is S-shaped. The first part of the S-curve approximates an exponential curve, but then levels out. That is, a technology starts improving slowly, then accelerates, and finally reaches maturity, at which point no further improvement is possible. "

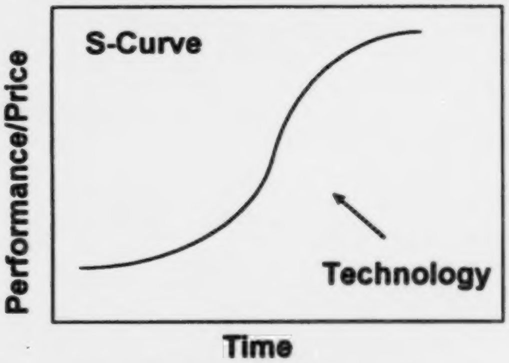


Figure 1. Rate of Technology Improvement

With some modification, Figure 1 is reproduced from the Report (2). Performance as the dependent variable is replaced with Performance/Price ratio. It is recognized by this author that although many technologies may follow a well defined S-Curve in their development, it is clear that many technologies do not. Also, in describing the maturity of any technology it is a subjective opinion as to where along the S-Curve (assuming it follows an S-Curve) the technology currently resides. Later in the paper, criteria will be established for determining the point where a given technology resides on the S-Curve.

3.3. FACTORS GOVERNING TECHNOLOGY DEVELOPMENT

Three domains govern the use and continued development of a technology:

1. *Technological feasibility*: The set of capabilities must produce the feature set associated with the product.
2. *Sociological acceptability*: People have to want the product the technology supports.
3. *Economic feasibility*: The product has to generate the revenue required to support the industry supplying it.

The author contends that all issues related to the acceptance of technology can be relegated to these three domains. Paradoxically, although these domains seem intuitively exclusive from one another, they are interrelated (Figure 2) and cannot be entirely separated. As a result it is difficult ,if not impossible, to make a statement about a specific technology that does not, either implicitly or explicitly, include elements in each of the three domains.

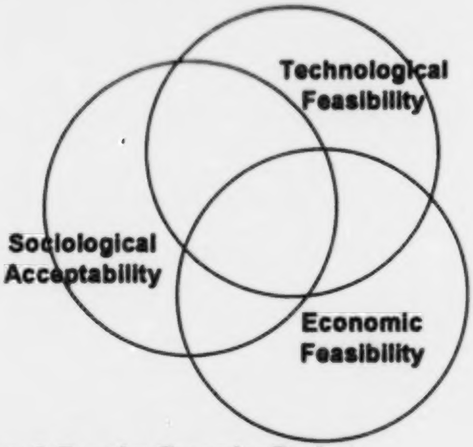


Figure 2. Domains Governing Product Adaptation

3.3.1. TECHNOLOGICAL FEASIBILITY

In order for a technology to develop it has to first be capable of creating a product with the desired feature set. Once it is found to be capable in that respect the technology will proceed to some level of maturity. Almost always, there is more than one technology that satisfy a particular feature set. When different technologies create the same feature set in a product the technologies interact in the following ways:

1. *Competitive:* They compete against an existing technology in producing a product.
2. *Successive:* They succeed an existing technology in producing a product.
3. *Preceding:* They precede another technology in producing a product.
4. *Novel:* They produce a novel product and neither compete with or succeed an existing technology.

Succeeding and Preceding technologies are current technologies that provide the same or equivalent product but are in different stages of their development cycle. Preceding technology emerges prior to the Succeeding one and is generally closer to its maturity that the later emerging Succeeding technology. A Succeeding technology will supplant a Preceding technology when it achieves a significantly superior Performance/Price ratio.

At the point where the Preceding and Succeeding technologies are perceived to be capable of the same Performance/Price ratio, they become Competing technologies. When different technologies are in competition they both mature at an accelerated pace. An example of Preceding and Succeeding technologies becoming Competing technologies is when the electricity began to compete directly against gas for providing lighting service. The gas industry introduced the rare-earth mantle which boosted the candlepower of the gas flame seven-fold and allowed it to compete for a time against the brighter output of the electric light. The rare-earth mantle now finds it primary use in decorative gas street lights and campsite lanterns.

Variations of a given technology are also competing technologies. Examples of this are different computer operating systems, microprocessor designs, and Software.

It is, of course, possible for two technologies to emerge nearly simultaneously, both with nearly the same Performance/Price ratio. The Beta versus VHS format competition is a now famous example of two such technologies. The technology that moves up the Performance/Price curve more quickly is the most likely to succeed and may prevent the competitor technology from fully maturing. With aggressive marketing, the VHS industry captured the consumer market and effectively relegated the Beta industry to a smaller niche market.

Novel technologies support a novel product and/or service and neither compete with or, succeed or precede existing technologies. Although one can imagine that there must be instances of novel technologies they prove difficult to identify. This is because most societal needs have always been satisfied in some way even though they may not have been satisfied cost effectively. For instance, communications, computation, and travel may have been crude and slow in the past but they still embodied technologies that were eventually supplanted by more modern versions.

One should take note of the personification that has been associated with the technologies since, of course, technologies do not, in and of themselves, compete with or succeed other technologies; it is the people associated with the technologies that are competing for the viability of the technology in the marketplace. This again illustrates that technology is a social construct.

3.3.2. SOCIOLOGICAL ACCEPTABILITY

The technology and the service that it provides has to be of some value to the user of that technology or the technology will be abandoned. The value of a product changes over time due to changes in societal perceptions. As an example, at one time phones were considered to be a luxury but now are widely considered to be a necessity.

Products can quickly become highly valued as a result of events. After tragic deaths from carbon monoxide poisoning were reported nationally, CO detectors quickly came to market. The first units were costly and required AC power to operate. The market response was sufficient enough to spur the industry to develop the technology to the point where this year units cost about $35 and run on batteries.

3.3.3. ECONOMIC FEASIBILITY

The product has to generate the revenue required to support the industry base utilizing the technology and producing the product. If this condition is not met then the industry and the technology it has created will disappear. (3)

3.4. THE S-CURVE AND TECHNOLOGY MATURITY

As stated earlier the rate of improvement for a given technology is S-shaped. The technology improves slowly, then accelerates, and slows again when it reaches maturity. A technology following the S-Curve then can be said to have three distinct phases: 1) Emerging, 2) Accelerating, and 3) Maturing (Figure 3).

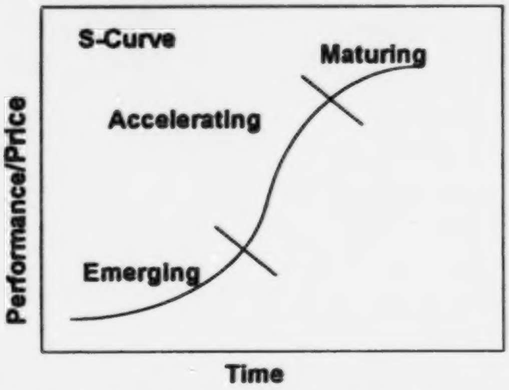


Figure 3. Phases of Technology Development

The rate of improvement in any of the three phases is due to the combination of four factors: 1) industry base size, 2) complexity of technology, 3) presence of competing technologies, and 4) perceived value of the associated product. A increasing industrial base hastens the rate of improvement of a technology. The more complex a technology is, the slower its rate of development will be. The presence of competing technologies will increase the rate of improvement for a given technology. A higher perceived value of a product translates into a higher profit margin for the industry which in turn hastens the rate of improvement for a given technology. The perceived value is related to the Performance/Price Ratio but reflects the value that the user sees in the product. All of these factors combine to influence the rate of improvement.

It is also a premise of this paper that when competition is present and the industry base large enough the development of technologies will approximate the S-Curve. To be more fully developed, this requires further study.

3.4.1. EMERGING PHASE

During the Emerging phase the rate of improvement for a given technology is slow. Development of the technology continues because the industry base utilizing the technology recognizes in it the potential it has in producing a superior product. In the Emerging phase, a technology may produce either no product or a product that typically supports only a small industry base. Factors that contribute to a slow rate of improvement during this phase are small industry base, high degree of complexity, no other competing technologies, and/or a low perceived value for the product.

Fusion based power generation is an example of a technology with a relatively long Emerging phase. The Department of Energy has set a goal to operate a demonstration power plant by the year 2025. The current value of the product of this technology is low, the complexity of the technology is very high, the size of the industrial base supporting it is large due to the Government funding, and competing technologies exist. With the exception of the industrial base size this technology fits the criteria of a Emerging technology well.

3.4.2. ACCELERATING PHASE

The transition from the Emerging phase to the Accelerating phase is marked by two events. First the product arising from the technology achieves market viability and secondly the industry base using the technology increases in size to take advantage of this market opportunity.

During the Accelerating phase, a given technology is in competition with other technologies. It is this competition, along with the larger industry base, that moves a technology through the Accelerating phase. The performance of the product typically improves dramatically while the cost to produce the product drops. Without competition or a larger industry base the technology will improve at a slower rate, perhaps as slow as the Emerging phase rate of improvement.

Factors that contribute to a fast rate of improvement during this phase are increasing industry base, decreasing degree of complexity, competing technologies, and/or a high perceived value for the product. The degree of complexity of the technology decreases during this phase because the characteristics associated with the technology are better understood by a larger base of people.

3.4.3. MATURING PHASE

The transition from the Accelerating phase to the Maturing phase is marked by a slowing of the rate of product performance improvement and a stabilization in the cost of producing the product.

During the Maturing phase, if the technology is still in competition with other technologies and the industry base is still large then this is an indication that the current performance limits of the given technology are being approached. If the technology is no longer in competition and/or the industry base has been reduced then it is possible that the limits of the technology have not been reached. The rate of improvement in this situation may be slow and resemble that of the Maturing phase but the renewed presence of competition can hasten the rate of improvement again..

Factors that indicate that the Maturing phase is being entered are: a declining rate of improvement during this phase are decreasing industry base, increasing degree of complexity, and a continued presence of competing technologies. The degree of complexity of the technology increases again during this phase because the limits of the technology are being approached which in itself tends to increase the complexity of using a given technology. The value given to a product has little influence on the rate of improvement during this phase since there is little improvement to be gained.

3.4.4. PHASE/FACTOR MATRIX

Figure 4 provides a table of the factors effecting the rate of improvement for the three technology development phases. By mapping a given technology on this table of values it can be used to provide some rationale for the location of the technology at a point on the S-Curve.

Technology Phase Improvement Factors	Emerging	Accelerating	Maturing
Industry Base	Small	Increasing	Decreasing
Complexity	High	Decreasing	Increasing
Competition	Maybe	Yes	Yes
Value	Low	High	—

Figure 4. Matrix of Improvement Factors

4. KEY GII TECHNOLOGIES

The technologies chosen for analysis were Computers, Software/Applications, Network Protocols, and Transmission Systems. Transmission Systems have a number of distinct competing technologies which are examined individually. They are Fiber Optics, Community Antenna Television (CATV), Copper Twisted Pair, Satellite, and Terrestrial Wireless.

It is assumed that each of the technologies chosen approximates the S-Curve in their development because of the presence of competition and the large industry base of each of the technologies.

4.1. COMPUTERS

Computer technology encompasses semiconductors, storage devices (such as CDROMs and Hard Drives), and displays. It is well known that computers are becoming cheaper, faster, better, and more portable. A number of sources indicate that this trend should continue for another 10 to 20 years as succeeding technologies replace the current ones (4,5,6,7).

Technology Phase Improvement Factors	Emerging	Accelerating	Maturing
Industry Base	Small	[✓ Increasing]	Decreasing
Complexity	High	Decreasing	[✓ Increasing]
Competition	Maybe	[✓ Yes]	Yes
Value	Low	[✓ High]	—

Figure 5: Mapping of Computer Technology

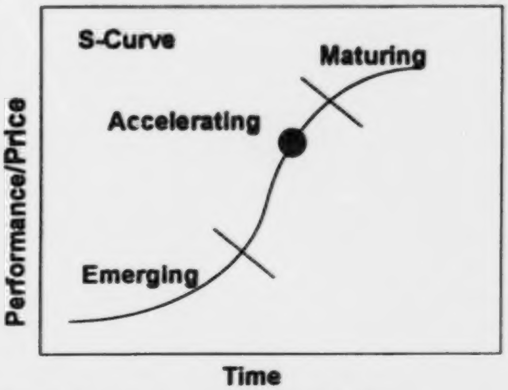
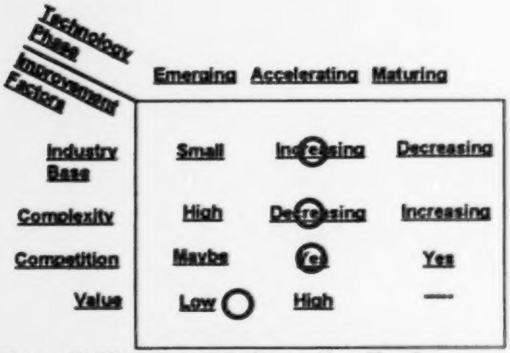


Figure 6. Computer Technology S-Curve Location

Semiconductor manufacturing is becoming increasingly more complex indicating that it is entering a Maturing phase (8). These things indicate that as a whole Computer technology is still in the Accelerating phase although parts of it may be Maturing.

4.2. SOFTWARE/APPLICATIONS

Software/Application technology operates computers. Bugs and crashes continue to plague software (1). Incompatibility of software products between manufacturers and the relatively low value of the products indicate that Software/Application technology is in the beginning of the Accelerating phase and improvements in technology can be expected.



Technology Phase / Improvement Factors	Emerging	Accelerating	Maturing
Industry Base	Small	[✓ Increasing]	Decreasing
Complexity	High	[✓ Decreasing]	Increasing
Competition	Maybe	[✓ Yes]	Yes
Value	[✓ Low]	High	—

Figure 7. Mapping of Software/Application Technology

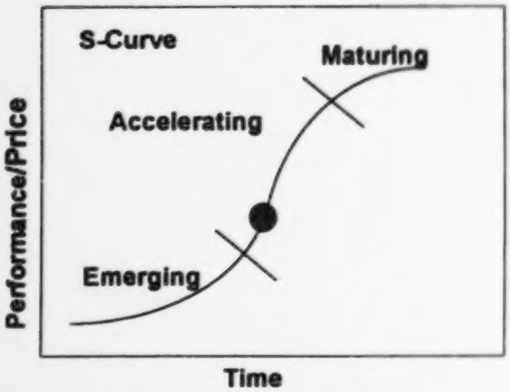
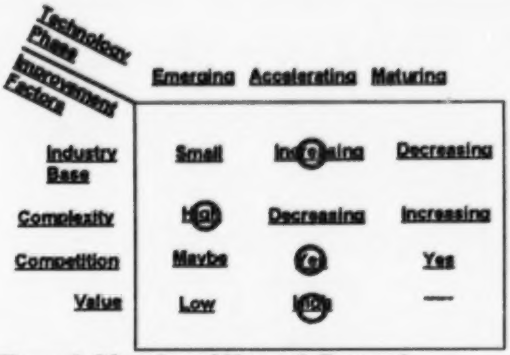


Figure 8. Software/Application Technology S-Curve Location

4.3 NETWORK PROTOCOLS

A large industry base is amassing to effect the transition from low bit rate protocols to the high bit rate feature rich protocols of future (9,10). A variety of constraints such as backward compatibility, open architecture, and interoperability, cause the complexity of Network Protocol technology to be high. As a result of these factors, Network Protocol technology is deemed to reside in the early part of the Accelerating phase indicating that the rapid rate of improvement should continue for some time.



Technology Phase / Improvement Factors	Emerging	Accelerating	Maturing
Industry Base	Small	[✓ Increasing]	Decreasing
Complexity	[✓ High]	Decreasing	Increasing
Competition	Maybe	[✓ Yes]	Yes
Value	Low	[✓ High]	—

Figure 9. Mapping of Network Protocol Technology

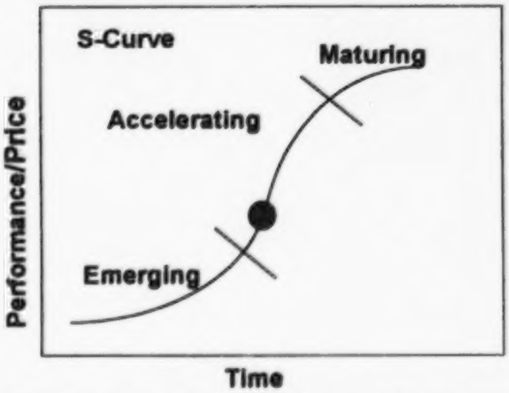
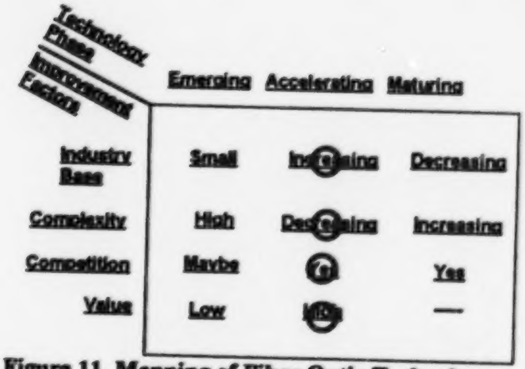


Figure 10. Network Protocol Technology S-Curve Location

4.4. TRANSMISSION SYSTEMS

4.4.1. FIBER OPTIC

Fiber Optic technology is well understood at this time. Predictions for capacity and cost (11) indicate that this technology is in the center of its Accelerating phase.



Technology Phase / Improvement Factors	Emerging	Accelerating	Maturing
Industry Base	Small	[✓ Increasing]	Decreasing
Complexity	High	[✓ Decreasing]	Increasing
Competition	Maybe	[✓ Yes]	Yes
Value	Low	[✓ High]	—

Figure 11. Mapping of Fiber Optic Technology

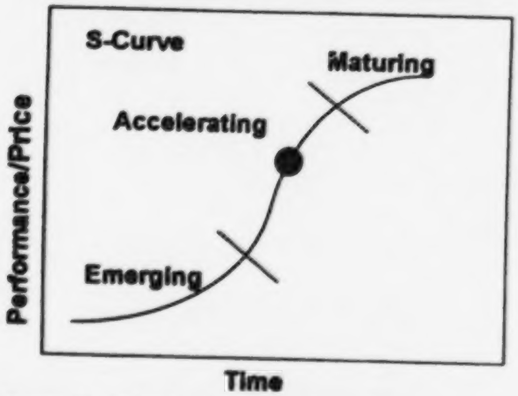
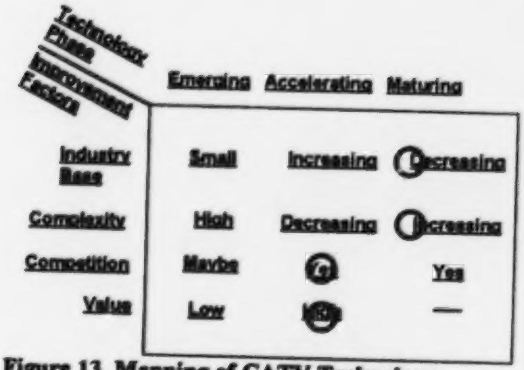


Figure 12. Fiber Optic Technology S-Curve Location

4.4.2. COMMUNITY ANTENNA TELEVISION

CATV technology currently delivers upwards of 1 gigahertz of bandwidth to the residential home (12). Fiber Optics has been added to the technology allowing CATV to extend it delivery range. Competition has been revived through the Direct Broadcast Systems (DBS satellite) offerings. Achieving new improvements has come at the cost of increasing complexity at a time with the industry base is declining. This indicates that CATV technology is approaching if not entering a Maturing phase.



Technology Phase / Improvement Factors	Emerging	Accelerating	Maturing
Industry Base	Small	Increasing	[✓ Decreasing]
Complexity	High	Decreasing	[✓ Increasing]
Competition	Maybe	[✓ Yes]	Yes
Value	Low	[✓ High]	—

Figure 13. Mapping of CATV Technology

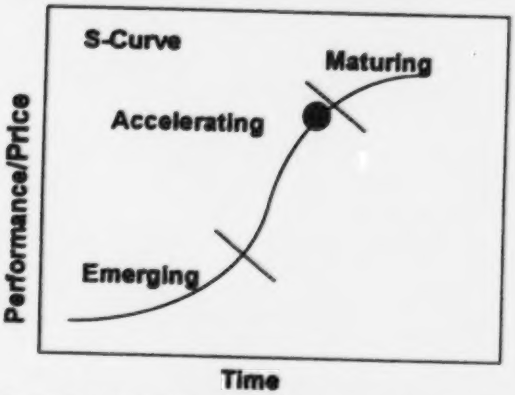
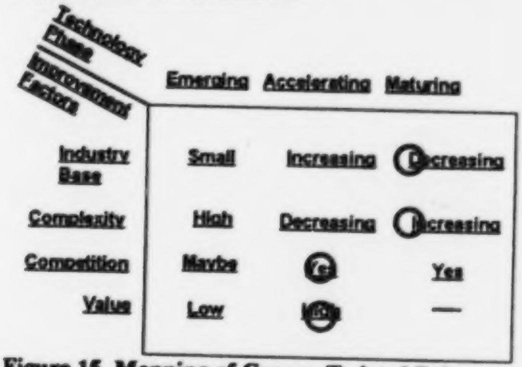


Figure 14. CATV Technology S-Curve Location

4.4.1. COPPER TWISTED PAIR

Copper Twisted Pair is an old technology that is trying to improve in response to renewed competition (13,14). The complexity of the technology is increasing while the industry base is decreasing. This indicates that Copper Twisted Pair technology is entering, or has entered, a Maturing phase wherelittle improvement will be realized.



Technology Phase / Improvement Factors	Emerging	Accelerating	Maturing
Industry Base	Small	Increasing	[✓ Decreasing]
Complexity	High	Decreasing	[✓ Increasing]
Competition	Maybe	[✓ Yes]	Yes
Value	Low	[✓ High]	—

Figure 15. Mapping of Copper Twisted Pair Technology

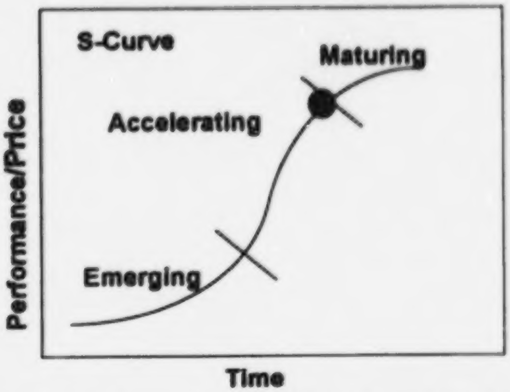
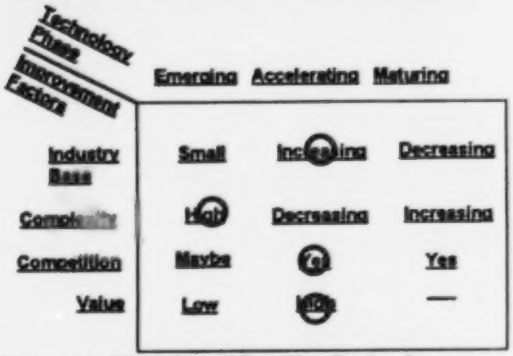


Figure 16. Copper Twisted Pair S-Curve Location

4.4.1. SATELLITE

Satellite technology is currently undergoing a major transition as it develops Low and Middle Earth Orbit satellite systems and adds higher frequency bands to capabilities. The complexity of the technology is high, the industry base increasing, and the value of the product is still low (9,10, 15). These indicate that the technology is just entering the Accelerating phase.



Technology Phase / Improvement Factors	Emerging	Accelerating	Maturing
Industry Base	Small	[✓ Increasing]	Decreasing
Complexity	[✓ High]	Decreasing	Increasing
Competition	Maybe	[✓ Yes]	Yes
Value	Low	[✓ High]	—

Figure 17. Mapping of Satellite Technology

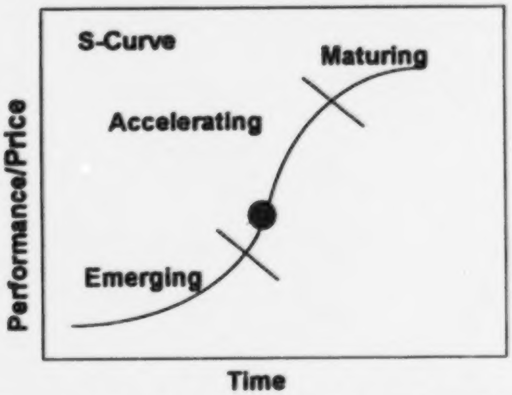
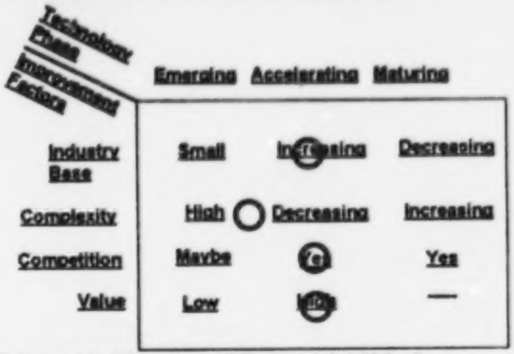


Figure 18. Satellite Technology S-Curve Location

4.4.1. TERRESTRIAL WIRELESS

A flurry of activity is taking place in Terrestrial Wireless technology (16,17). New spectrum is being made available. Wireless LAN specifications are underway. An increasing number of cellular towers are being erected. Wireless services are now beginning to compete directly against the wired infrastructure (14). The complexity of the technology appears to be decreasing as the cost of the product declines. The industry base is clearly increasing. All this indicates that Terrestrial Wireless technology is at the first portion of the Accelerating phase.



Technology Phase / Improvement Factors	Emerging	Accelerating	Maturing
Industry Base	Small	[✓ Increasing]	Decreasing
Complexity	High	○ Decreasing	Increasing
Competition	Maybe	[✓ Yes]	Yes
Value	Low	[✓ High]	—

Figure 19. Mapping of Terrestrial Wireless Technology

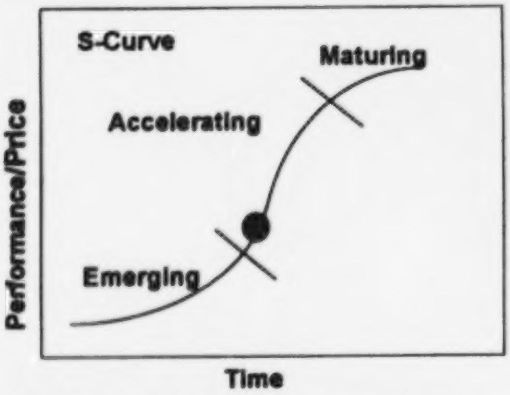


Figure 20. Terrestrial Wireless Technology S-Curve Location

6. CONCLUSIONS

All of the technologies examined are in the Accelerating phase with the possible exception of Copper Twisted Pair. The Transmission System technologies are competing against each other in an area where large improvements are expected and where the value of the products are high.

Software/Applications, Network Protocols, Satellite, and Terrestrial Wireless technologies are in the initial portion of the Accelerating phase and as a result may offer the greatest rate of improvement in products that will be part of the GII.

Software/Applications technology may be most influential because of its pervasive nature in most of the technologies examined and its low position in the Accelerating phase.

The rapid pace of development can be a hindrance in itself. Computer technology with its constant improvement of a well understood feature set will provide an anchor for the other technologies to attach to.

Those technologies approaching the Mature phase should be vulnerable to competing technologies in the Accelerating phase. Thus, the Copper Twisted Pair and CATV technologies may be supplanted by Fiber Optics, Satellite, and/or Terrestrial Wireless.

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Global Quality of Service-based and Reliable Data Dissemination via Asymmetric Direct Broadcast Satellite Channels

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Abstract

Satellites possess the ability to broadcast to an arbitrarily large, potentially mobile receiver population, and thus have a unique role to play in the future Global Information Infrastructure (GII). To realize the seamless integration of satellites into the GII, one must consider not only the unique characteristics of satellite systems, but also the future composition of the GII. In this paper we will present a survey of the current and evolving Internet networking technologies and protocols that we think will, in the near term, constitute a major portion of the GII. We will put forth a taxonomy of issues that must be addressed to integrate asymmetric direct broadcast satellite (DBS) systems into the GII to support delivery of Internet Protocol (IP) and Asynchronous Transfer Mode (ATM) Quality of Service (QoS)-based flows and reliable multicast data over asymmetric, high latency, limited bandwidth satellite links.

1. INTRODUCTION

Satellites possess the ability to broadcast to an arbitrarily large, potentially mobile receiver population, and thus have a unique role to play in the future Global Information Infrastructure (GII).

Many future direct broadcast satellite (DBS) systems will have an *asymmetric* architecture--*high* data rate forward broadcast, *low* data rate return links (possibly from mobile wireless users)--and communication protocols are necessary to intelligently exploit this asymmetry. Also, present satellite communication links can be characterized as having high latency, moderate noise characteristics and limited bandwidth relative to fiber-based communications. While Forward Error Correction (FEC) techniques can be used to essentially remove the effects of noise (recent tests have already achieved bit error rates ranging from 10^{-9} to 10^{-11}), information theory and simple physics tell us that limited channel capacities and high delays will forever remain characteristics of satellite systems. Thus, while noise is a near-term problem for some existing systems, all future satellite systems will require mechanisms for *efficiently managing bandwidth* and *properly handling latency*. To realize the seamless integration of DBS systems into the GII, one must consider not only the unique characteristics of these satellite systems, but also *the future composition of the GII.*

Future Traffic Patterns

In the future, we envision satellite broadcast traffic consisting of long-lived "pushed" and short-lived "pulled" data flows. Pushed data can be thought of as that corresponding to a well known information flow like a video transmission, whereas pulled data is something akin to an asynchronously requested data transmission (perhaps a web-based request). It is likely that pushed data will be multicast, whereas pulled data is most likely of interest only to the requester and is thus sent via unicast. Of course, one can envision examples where a user request initiates a multicast session, or a long-lived flow is simply a unicast transmission.

In a bandwidth-constrained satellite system, some mechanism will be necessary to manage the bandwidth allocation between these two broad traffic classes, as well as between the various "pushed" and "pulled" information flows, to facilitate seamless integration with the global Internet. If this is not done, Internet QoS-based flows cannot be carried over the satellite channel.

Internet Technology in the GII

The Internet seems certain to play a large role in the GII. Its traditional "best effort" service model is very robust and, with suitable adaptations, has proven capable of running effectively over heterogeneous combinations of link layer technologies. From the Internet perspective, Asynchronous Transfer Mode (ATM) networks are another subnetwork technology, albeit with a rich functional capability . The addition of satellite connectivity to the Internet's backbone adds yet another technology to the mix over which the Internet may operate.

The Internet is also undergoing a sea change--rapidly transitioning from its traditional service model to one which supports both best effort and Quality of Service (QoS)-based delivery. This so-called Integrated Services (IS) model [Braden94,Clark92] requires an enhanced architecture which supports *best-effort, real-time, and controlled link sharing services* through effective bandwidth guarantees over an internetwork. Integration of satellites into the GII will require support for this new architecture and its protocols, as well as the usage of the enhanced network services it provides to address satellite interoperability issues in novel ways.

IP multicast [Deering89] is another rapidly evolving Internet paradigm. Multicast is a natural mechanism for delivering video, voice and other broadly disseminated forms of information (one-to-many and many-to-many sessions), and is well suited for use over satellite broadcast channels. To deliver IP multicast flows via satellite at a specified QoS level, a *bandwidth management* approach compatible with the IS model is necessary.

Efficiently supporting *reliable* delivery of information via satellite is also critical for seamless integration. The Internet currently supports reliable transport layer information delivery using TCP [Postel81]. Standard versions of TCP suffer from well known performance problems over high bandwidth-delay product links, and several extensions to improve performance are given in [Jacobson92]. At Eumetsat, recent (undocumented) tests of these extensions over 1.152 Mbps satellite links with 10^{-8} BER have shown throughputs of 1 Mbps are obtainable--work on establishing 3.5 Mbps sessions is ongoing. More recent work [Fall96,Floyd96], termed "Sack TCP", adds selective acknowledgment features to TCP and appears well suited for use over forward-error-corrected (i.e. low error rate) satellite links of the type envisioned in future systems.

However, what none of the preceding work addresses is the issue of *asymmetry,* and the special ways in which TCP can and should be modified for use in asymmetric systems. Also, TCP only supports reliable *unicast* delivery. A necessary feature for future satellite systems will be protocols to support *reliable IP multicast* over asymmetric channels.

In this paper, we will present a survey of the current and evolving Internet networking technologies and issues that we think will, in the near term, be relevant to the integration of satellites into the GII. As stated, the key characteristics of many future DBS systems are their *asymmetric architecture, limited bandwidth* and *high latency.* We will put forth a taxonomy of issues that must be addressed to integrate asymmetric DBS systems into the GII to support mixed delivery of IP and ATM QoS-based flows and reliable multicast data over asymmetric, high latency, limited bandwidth satellite links. This requires bandwidth management of the satellite broadcast, as well as appropriate use of multicast and unicast communication technology. We will first consider issues regarding bandwidth management, and then focus on communication technologies suitable for enabling effective information push and pull.

2.0 Protocol Issues

2.1 Bandwidth Allocation and Management

A satellite broadcast will likely consist of many forms of multiplexed Internet traffic (e.g. data, images, voice, video), which must be allocated over the satellite downlink in some fashion--the various forms of traffic require differing QoS guarantees from the network.

IS Model

Within the Internet, supporting multiple traffic quality levels and effective link sharing guarantees over an internetwork requires an enhanced architecture, and the term *integrated services (IS)* is often used to refer to an enhanced Internet service model including *best-effort, real-time, and controlled link sharing services* [Braden94,Clark92]. There are two basic core components of this new IS architecture:

- Traffic control: what support is provided for classifying, admitting and forwarding packets?

- Flow reservation setup and maintenance: how is service specified and established?

Flow reservations are explicitly established via mechanisms such as RSVP [Zhang93,Braden96] or ST-II [Forgie79,Topolcic92]. The traffic control segment of this model includes three components: the packet scheduler, the classifier, and admission control [Braden94]. Weighted Fair Queueing (WFQ) is one form of packet scheduling. Using WFQ, routers establish separate queues per flow to enable QoS provisioning. These flows are serviced in a "round robin-like" fashion.

To effectively share the portion of a satellite broadcast allocated to Internet traffic, a *unified methodology* is necessary which permits minimum QoS guarantees, yet allows efficient sharing of unused bandwidth when available. In other words, a method is needed by which the forward channel may be sensibly "shared" between many competing traffic classes.

CBQ

The concept of "Class-Based Queueing" (CBQ) developed at Lawrence Berkeley Laboratory (LBL) [Floyd95a] seems well suited for use as a methodology for link sharing in this asymmetric architecture. CBQ is a paradigm that unifies and handles all three aspects of traffic control.

The concept starts with the notion of controlled link sharing between multiple organizations or agencies (i.e., perhaps between agencies sharing a satellite) allowing *minimum* bandwidth guarantees to each agency as required. A representation of a controlled link sharing scenario is shown in Figure 1 (only a two-level example is shown, but CBQ works for higher-level hierarchies). The communication link or resource at the top of the tree represents 100% of the available bandwidth to share for the Internet traffic. This total bandwidth is divided amongst groups 1-3, and each group (i.e., IDS) is provided a minimum bandwidth allocation guarantee. The final tier on the tree represents individual data flows and each is allocated a minimum percentage of a group's bandwidth.

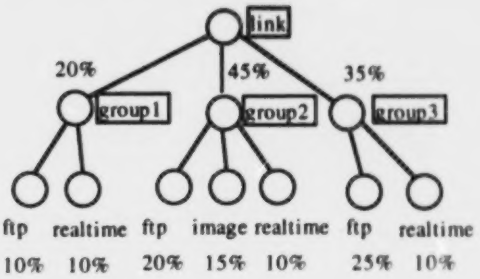

Figure 1: CBQ hierarchical link sharing

When bandwidth is not in use by a particular flow, others can use it. The borrowing and recovery of bandwidth from other flows is governed by the *hierarchical* arrangement of allocations, and the location of the overdrawn flows. Flows first borrow unused bandwidth allocated to other flows within their group, and then from those in other groups in a structured fashion as specified by the hierarchy. We refer to this process as "structured stealing" of bandwidth. This provides a novel means for implementing a sharing policy directly within the packet forwarding and scheduling scheme itself. The CBQ model can be adapted to also provide allocations for real-time traffic flows by guaranteeing bandwidth and low delay for designated high priority services.

A form of CBQ has already been used to improve traffic management across the Trans-Atlantic link (FAT pipe) connecting various internetworking entities: the UK MoD and the US DoD, NASA and the European Space agency (ESA), and the UK academic IP network and the US academic network. This has allowed movement away from inefficient "hard" sharing approaches (i.e., fixed multiplexing via static bandwidth allocation) to more efficient "soft" sharing approaches. Each agency is guaranteed a fixed percentage as a minimum bandwidth for mission operation, and unused bandwidth within these percentages is reallocated dynamically to handle any excess traffic. The CBQ concept, with its emphasis on a multiple queue class hierarchy, matches well with anticipated controlled link sharing requirements. While providing high assurance networking services to designated data flows, it also integrates policy-based sharing associated with interconnecting agencies or mission area components across common resources.

Such a sharing policy could be implemented at an uplink manager (an IS-capable router) to control bandwidth allocation between multiple agencies sharing a satellite service. Various agencies could be given bandwidth appropriate for their average information "push" data dissemination needs. As these averages vary, the bandwidth percentages can be slowly adjusted. Additional dynamic headroom could be left free to accommodate anticipated changes in the quality of the satellite link due to weather (the effective information rate will drop as FEC levels increase during bad weather), as well as to permit asynchronous information "pull" requests. In this approach, satellite bandwidth is partitioned into two broad categories at a top hierarchy level, giving appropriate amounts of bandwidth to the push and pull traffic classes, and then subdivided more finely into subclasses and flows as appropriate.

The implementation of CBQ requires and, at the same time, unifies a number of essential elements required in future traffic controller designs: packet classifier, packet scheduler and queue manager. These are the key elements required to support multiple traffic quality levels and effective link sharing guarantees over an internetwork.

Recall, the problem we are concerned with here is the integration of asymmetric DBS systems into the GII. This requires interoperability of all IP-based network services in the "forward" channel from sources to destinations. This channel not only includes the satellite link, but also those in the ground networks. The IS model must be supported throughout these networks in an end-to-end fashion to be effective. Introduction of the IS model into products by major Internet routing vendors is expected to begin in early 1997. Therefore, it is not anticipated to be long before portions of the Internet backbone are capable of supporting QoS.

2.2 Coexistence of IP and ATM

The GII will consist of a mixture of communication technologies: e.g., ATM, IP; SONET, Frame Relay, wireless, satellite-based, etc.. QoS-based network services will likely be provided by both IP and ATM networks.

Currently, IP and ATM each have there own forms of traffic classes and QoS parameters. At present, there does not exist a direct mapping between the two sets of traffic specifications. Some forms of traffic from one QoS model may be easily carried within the other's traffic classes, although the details of this have not been worked out. For instance, while either will work, there is currently debate as to whether Available Bit Rate (ABR) or Unspecified Bit Rate (UBR) is the most appropriate traffic class in which to carry TCP traffic within ATM networks. Other forms of traffic with strict QoS guarantees are not so easily supported over heterogeneous networks.

To enable sharing of the forward broadcast channel between IP and ATM traffic while still maintaining QoS, the most straightforward approach for supporting both traffic families is strict separation between the two in terms of dynamic scheduling. If the link-level framing is some form of ATM over satellite (the satellite channel is ATM-based with an ATM switch at the uplink manager), then any CBQ-scheduled IP traffic can be carried within a Constant Bit Rate (CBR) ATM allocation, thus isolating the dynamics of each scheduling discipline from the other. Equivalently, if low bandwidth ATM traffic is being sent through an Internet IS-capable router, then the ATM traffic may be encapsulated within a constant rate IS flow.

The net effect is to statically separate the satellite broadcast capacity into two parts, one controlled by ATM-based scheduling policies (where underlying ATM exists) and the other by CBQ or some other IS-compatible Internet QoS scheduling policy. Of course, there is a loss of efficiency that comes with any static allocation, but hopefully the loss will not be very large as there is only one such partition. To implement a more efficient scheduling paradigm requires first determining an appropriate mapping between the two QoS models.

2.3 Information Pull via Asymmetric TCP

With the preceding approach, some minimal fraction of bandwidth on the satellite channel may be reserved for asynchronous, atomic, information pull applications such as web browsers. Of course, additional bandwidth may be borrowed if available. But, at any time, only a finite amount of bandwidth will be present. Within this allocation, competing unicast flows will need to handle congestion and flow control.

Classic reliable data transport protocols, like TCP, apply a robust, reactive approach to achieving optimal flow control. The DBS networking architecture is asymmetric where, again, "asymmetric" refers to the large "receive" pipe and small "return" channel. The large receive pipe is a high bandwidth-delay channel, and allows for a large amount of bits "in transit". The return channel is likely to support only a small amount of information in comparison, and has increased likelihood of congestion and overall delay (again, the view is that the users may even be mobile and wirelessly connected with limited return bandwidth).

Adaptive flow control techniques like TCP measure Round Trip Times (RTT) and use this as a means to adjust a window-based flow control scheme. TCP attempts to adjust the number N of "in transit" packets (the transmission window) to the product of the transmission rate at the most congested link with the one-way transmission delay - N is the so-called bandwidth-delay product. TCP requires approximately $\log_2(N)+N/2$ RRT's to open its transmission window to this optimal size [Keshav91], and continuously oscillates in steady state about this correct operating point even if the available capacity is constant. This classic approach is known to perform poorly over high-bandwidth delay links, and will perform sub-optimally in an asymmetric architecture, due to increased difficulty for the protocol to accurately measure and react to the actual delay-bandwidth product for the high bandwidth unidirectional links.

DirecPC

Adding simple, retransmission-based error recovery to enable reliable unicast delivery over an asymmetric DBS link is fairly straightforward. Work performed in 1994-95 at the University of Maryland in conjunction with Hughes Network Systems enabled TCP functionality to be extended over an asymmetric satellite channel allowing TCP/IP-based, client-server applications such as e-mail, FTP, Telnet, Gopher, and the Web to be used by home computer users [Arora94]. Techniques known as "spoofing" and "acknowledgment dropping" are used to enable asymmetric TCP operation. This work culminated in a Hughes product known as *DirecPC*, which uses an asymmetric combination of satellite and terrestrial links to supply a home user with a high bandwidth downlink via satellite up to 400 kbps from the Internet (required to deliver large files (images) to the user), and a low bandwidth connection (phone line) to the Internet (required to carry the relatively light traffic of the user's requests). Specific enhancements to TCP such as those of [Jacobson92] are being added to the *DirecPC* product to improve performance. If standardized, the modifications specified in Sack TCP may also be added.

The difficulty with the preceding TCP implementations is that they do not properly account for the *asymmetry* of the end-to-end connection. Within the larger topology of the Internet, the DBS broadcast forms a high bandwidth, unidirectional link. Sack TCP and other long fat pipe enhancements are intended for use in symmetric network architectures, which estimate the one-way transmission delay from a two-way round trip measure. This method is not appropriate for asymmetric connections. The *DirecPC* system uses a non-standard method of enabling integration of its DBS system into the larger Internet that does not perform one-way delay estimation. What is necessary in the future is a standard TCP enhancement that properly does so for asymmetric connections.

2.4 Information Push via Multicast

A satellite transmission is by its very nature *broadcast*, yet only a portion of the information being transmitted may be of interest to all receivers. To selectively group receivers interested in a common information flow, *multicast* networking support is becoming an increasingly important technology area for both commercial and military distributed or group-based applications. An increasing variety of distributed multimedia applications are being developed in which "consistent" and/or "reliable" data delivery to all (or a subset of) data packets is a critical performance factor. Reliable group file transfer (e.g., image dissemination) and interactive applications are also likely candidates as reliable multicast applications.

IP Multicast

The "IP multicast" paradigm provides a natural mechanism for highly dynamic group communications and interest filtering in the GII. Using IP multicast, receivers can be dynamically organized into groups based on shared information interests. IP multicast associates a "group" of receivers with an IP multicast "address". Anyone may be a sender to a group by sending to this address, including its own receivers. The underlying delivery mechanism for IP multicast is presently the User Datagram Protocol (UDP), or raw IP packets.

To enable the IP multicast paradigm to work in the GII, receivers joining a multicast group need not directly contact the source since; in this paradigm, senders are not aware of the identities of the receivers. However, they must contact an uplink manager via the reverse channel so that it may act as a surrogate for the receivers and have a multicast tree built to it so that information may then be sent over the satellite. Also, for some flows, additional security and key exchanges may be necessary to authenticate receivers and enable decryption of transmitted data. Once this is accomplished, all receivers need do is begin listening to a given multicast address. Should a receiver request initiate a long-lived data push, a multicast group address can be dynamically created and repeatedly advertised in a well known multicast information flow so that the requesting receiver (and any other interested receivers) may obtain the address.

Filtering

In the GII, the traffic being broadcast from a satellite will be multiplexed from many different sources, and will be bound for many different receivers. There are many ways in which the data transmission and reception pattern may be organized and managed. One approach is to perform all interest and information filtering at the "application" level. In many cases, filtering at this level will be unavoidable. However, it is very computationally intensive to do so, and a method which allows some filtering to occur at lower levels would be advantageous.

IP multicast group *addresses* can be used to organize and filter information at the "network level", which is more efficient. Receivers may be configured to listen to multiple multicast addresses, each specifying a particular information "interest" to pluck from the incoming broadcast data stream. For example, a multicast group address can be dynamically assigned to represent local weather data. Any receiver interested in the weather forecast simply adds this multicast address to the set which it is monitoring, and then automatically receives weather updates.

In its raw form, IP multicast efficiently provides low latency delivery. However, this delivery is only "best effort", appropriate for voice and video ("stream" traffic) which requires low delay variance in packet delivery, but can withstand occasional packet losses due to transmission errors (although the effects of such losses should be mitigated as much as possible, especially for MPEG video, through proper forward error correction (FEC) techniques).

Reliability

Best effort delivery implies that IP packets are treated with essentially equal weight, and while IP makes an effort to deliver all packets to their destination, packets may occasionally be delayed, lost, duplicated, or delivered out of order. In the past, such delivery mechanisms have worked reasonably well for supporting stream traffic insensitive to occasional lost or missing data such as voice. Through usage of the IS model and RSVP, QoS and bandwidth reservation techniques can be added to aid in increasing data stream robustness, but this approach alone does not solve the reliable multicast delivery problem.

To add end-to-end network reliability, a combination of FEC and retransmission is required. In satellite systems, FEC is primarily used to adapt the information transmission rate to the prevailing propagation conditions to obtain near error-free performance on the satellite links. However, during this adaptation process, errors still occur and packets/cells will be lost. Also, in an asymmetric satellite system, information flows traveling from an internetwork to and from the satellite, and through an internetwork to its receivers are also subject to packet/cell droppage in the ground networks' routers/switches and resultant end systems. The reliability mechanism in use should recover from these potentially nondeterministic error sources via retransmission.

2.4.1 Reliable Multicast

While reliable unicast transport is fairly well understood, adding retransmission-based *error recovery* to multicast is nontrivial, particularly over an asymmetric channel architecture. Due to the potentially immense scope of GII satellite-based distribution, a multicast protocol must avoid the well known message implosion effects that may occur when reliably multicasting to large receiver populations, while maintaining minimal delivery and error recovery latencies. Also, the distribution and error recovery mechanisms of a multicast protocol must be distributed, self-configuring and maintaining, as it would be impractical to control such a process manually, or in a centralized fashion.

Application-level Requirements

Application-level requirements vary and are crucial in determining an appropriate reliable multicast solution. Several such requirements are listed as follows:

- *Best effort* reliability is similar to that which is provided by the UDP-based IP multicast delivery schemes most commonly present today. No reliable delivery is guaranteed.

- *Absolute* reliability is the most familiar requirement. It states that all packets in a session be reliably delivered to the receivers. This is the form of reliability that is commonly supported by TCP at the transport layer for unicast sessions.

- *Most recent* reliability is reliable transmission where only the most recent data of a particular parameter is of interest. A simple example would be a service that provides reliable stock updates. If a particular stock update is lost, and a new update is received before a retransmission can occur, the old data is rendered useless. Thus, it is possible that the data may take on a value that is never known to some or all of the receivers. Most recent reliability is a common requirement for many data types in advanced distributed simulations and in situational awareness dissemination and is application specific.

It is likely that all these forms of reliability must be supported for the variety of applications envisioned within the GII.

Scaleability

For a reliable multicast protocol to be useful on a global scale, it must be *arbitrarily scaleable*. This requires scaleable storage management, flow control and error recovery which avoids message implosion effects.

GII applications will require reliable multicast support for "long-lived" sessions. We define a session to be *long-lived* if the total amount of information generated and transmitted in the session exceeds the application's storage capacity. Supporting such sessions is difficult, as it requires the ability to *store* information until it is reliably delivered, and then to *flush* this information. Consequently, a multicast approach supporting such sessions requires a *scaleable storage management mechanism* integrated into the error recovery protocol. While it would be desirable to have an uplink manager act as a surrogate source for purposes of data cacheing: since there may be many senders to a group, it may not be possible for the uplink manager to store this much data. Recall, an uplink manager may also be handling multiple multicast groups. Thus, data storage must remain at the sources. Storage constraints at the sender may impact flow control, as may the available buffer space at a receivers and the bandwidth available on the satellite channel.

2.4.2 Possible Approaches

Reliable multicast protocols can be grouped into two broad classes: "sender-reliable" and "receiver-reliable". Each classification is based on the sender's knowledge of the multicast group, and which party has the *responsibility* for state maintenance and the initiation of error correction.

Sender-reliable

For sender-reliable schemes (e.g. RAMP [Koifman96]), delivery is primarily the responsibility of the sender. The sender monitors the reception state of each receiver through positive acknowledgment (ACK) and issues repairs upon error detection. This is a basic selective repeat approach. However, IP multicast implies no direct relationship between senders and receivers of multicast data. This severely hampers the ability of a sender to track and maintain reception state for each receiver. Even if each sender is made aware of all receivers, a severe *ACK implosion effect* is created at each sender when the number of receivers grows large (e.g., > 10 participants) [Pingali93]. Thus, this is not well-suited for use in the envisioned architecture.

Receiver-reliable

For receiver reliable multicast, reliable delivery is the responsibility of the receivers. Each receiver maintains reception state and requests repairs via a negative acknowledgment (NAK) when an error is detected. Error detection is based on the receiver perceiving gaps in the data. This requires that individual packets be identified either with application-level framing [Clark90] or generic transport sequence numbers as in TCP. Low latency gap detection requires frequent data transmission, otherwise "heartbeat" [Holbrook95], "keep alive" [Koifman96] or "session" [Floyd95b] transmissions are necessary. In receiver-reliable systems, mixed levels of reliability can be achieved at a receiver. A receiver may choose to NAK any missing data it requires to be reliable.

Sender-oriented, receiver-reliable

In a "sender-oriented receiver-reliable" approach, error detection at a receiver results in a NAK sent to the sender. While intermediate receivers may have received the data for which the NAK is issued, only the sender is involved in issuing repairs. This approach is appropriate when receivers cannot effectively communicate with each other (perhaps for security reasons). However, such an approach ultimately limits scaleability due to a NAK implosion effect at the sender for large receiver sets. If receivers are somewhat capable of hearing each other's replies, a statistical backoff algorithm can be applied to somewhat limit NAK implosion among the receiver set. As the receiver set grows this implosion becomes more difficult to control without increasing response delay.Thus, such an approach is best suited for transmission of very large packets where a low ratio of NAK overhead to data content can be realized. This reduces the overall NAK implosion effect.

In a GII application, unchecked control message implosion is seen as disastrous, due to the potentially limited bandwidth available in the return direction.

"Flat" receiver-reliability

In a "flat" receiver-reliable approach to reliable multicast (e.g. SRM [Floyd95b]), receivers can communicate with each other to assist in error recovery. Each receiver caches data for some time or for the entire session. When an error is detected at a receiver, a NAK is issued which other receivers can hear since it is multicast to the group. When a receiver that has correctly received and cached the missing data receives a NAK, a repair can be issued. As described above for sender-oriented, receiver reliable, some NAK suppression can be realized with a pure probabilistic backoff strategy among the receiver group. To take advantage of state cached among the receiver group, a distributed repair scheme is used which further suppresses the number of control messages required per repair. To achieve this, the flat receiver-reliable scheme incorporates both *probabilistic* and *deterministic* NAK suppression strategies to maintain scaleability to an arbitrarily large number of receivers.

A drawback to a flat, receiver-reliable approach is that NAKs and repairs are *global* in scope. Thus, they consume bandwidth for the whole group, even for isolated packet losses. Enhanced localized scoping of repair messages is possible and can alleviate this effect. In general, a flat, receiver-based approach is highly fault tolerant and scaleable. Its biggest disadvantages are in the requirement to cache state at all receivers, and the use of global resources. The apparent performance advantages of a pure flat, receiver-reliable approach are not necessarily advantages in an asymmetric system. In such an architecture, it is likely unwise to attempt many localized repairs in the heterogeneous, potentially low data rate channel among the receivers. It is assumed here that the satellite channel has at least an order of magnitude increase in throughput capability and that it is serving up high bandwidth data (e.g., imagery, video).

To efficiently deliver information reliably to a large number of recipients via DBS, an appropriately engineered compromise of the preceding techniques is required to realize an asymmetric, scaleable reliable multicast protocol. Such a technology is necessary to enable reliable information delivery via the coming asymmetric DBS systems.

3.0 Conclusions

We have presented a survey of issues we feel crucial to integrating DBS systems into the future GII. We have conjectured that the Internet will have a large role to play in the GII, and have discussed communication protocol issues largely from this perspective. These issues include methods for managing the bandwidth of a DBS transmission, as well as issues regarding latency and the scaleability of asymmetric, reliable unicast and multicast communications.

Our conclusion is that there remains a large amount of work to be done in order to seamlessly integrate DBS systems into the GII and, in particular, the Internet. Many protocol standards or enhancements are required for asymmetric systems, e.g. asymmetric TCP and asymmetric scaleable reliable multicast to name two.

Work with this flavor is just beginning. At the most recent Internet Engineering Task Force (IETF) meeting in Montreal [MontrealIETF96], a session was held on the subject of UniDirectional Link Routing (UDLR), i.e., routing in networks where a subset of the links are unidirectional. In the context of the Internet's topology, a DBS transmission constitutes a set of unidirectional links, one from the uplink manager to each receiver. Most existing Internet routing algorithms assume bi-directionality and do not work over unidirectional links; thus, enhancements to these protocols are necessary to incorporate these links into the Internet topology. Once such links are incorporated into the Internet's routing fabric, and DBS systems can be seamlessly integrated; the protocol and resource management issues of the type discussed here will be necessary.

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8PSK Modulation: Maximizing Capacity For Broadcast Networks

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1. ABSTRACT

The use of high order modulation techniques like 8PSK and 16QAM over satellite links is growing as a way to increase the number of video channels delivered. A network/cable headend distribution model is presented, along with a preliminary link budget and tradeoffs for digital links. The modem and its contribution to the balance between power and bandwidth are presented to show the beneficial impact high order modulation has on increasing the data rate through the transponder.

2. INTRODUCTION

Digital transmission of high quality compressed video over satellite offers significant opportunities for increasing capacity. For broadcasters, it is the media of choice for increasing the quality and quantity of program material distributed to their affiliates, and for cable headend delivery it boosts the number of channels delivered. The implications for increased revenue and reduced cost has spurred interest and activity throughout the industry. However, even greater returns are achieved when 8PSK modulation is selected over QPSK for transmission over satellite. The right blend of elements in the satellite link make this possible, including:

- Digital Video Compression
- Satellite Transponder Power and Bandwidth
- Receive Station G/T
- High Speed Digital Modem
- Advanced Modulation And Coding Schemes

The satellite transponder is a key resource offering limited power and limited bandwidth, so any scheme devised must fit within those bounds. Higher order modulation schemes, like 8PSK and 16QAM, deal with bandwidth by reducing spectral occupancy (compared to lower order modulation methods, like QPSK). Power is conserved by using concatenated Reed-Solomon coding in tandem with trellis coding. Still, tradeoffs are required to balance the available power and bandwidth in the transponder with the right combination of modulation and coding to maximize throughput, and these are explored. Several system level calculations are presented, enabling a transmission link designer to estimate performance versus the limitations

3. DISTRIBUTION MODEL

The basic system model for digital video distribution over satellite is shown in Figure 1. Video compression takes place in the video encoder, which reduces the data rate of the source material from a typical uncompressed rate of 270 Mbit/s to a lower rate dictated by the level of video quality, the amount of editing, and other considerations. These rates range from 2 to 6 Mbit/s per individual stream for direct-to-home systems, and up to 15 Mbit/s for special events and services using MPEG2 4:2:0 compression. Other compression schemes for digital video include the DVC compression standard, delivering 4:1:1 video at 30 to 36 Mbit/s, and the ETSI component video standard producing 4:2:2 quality at 34.368 Mbit/s (E3) and 44.736 Mbit/s (DS3). Advanced Television (ATV) is standardizing on a format that produces 4:2:2 video at 19.39 Mbit/s. Other applications combine several lower data rate streams in a multiplexer to produce a single, composite, multi-channel data stream for transmission as a single carrier.

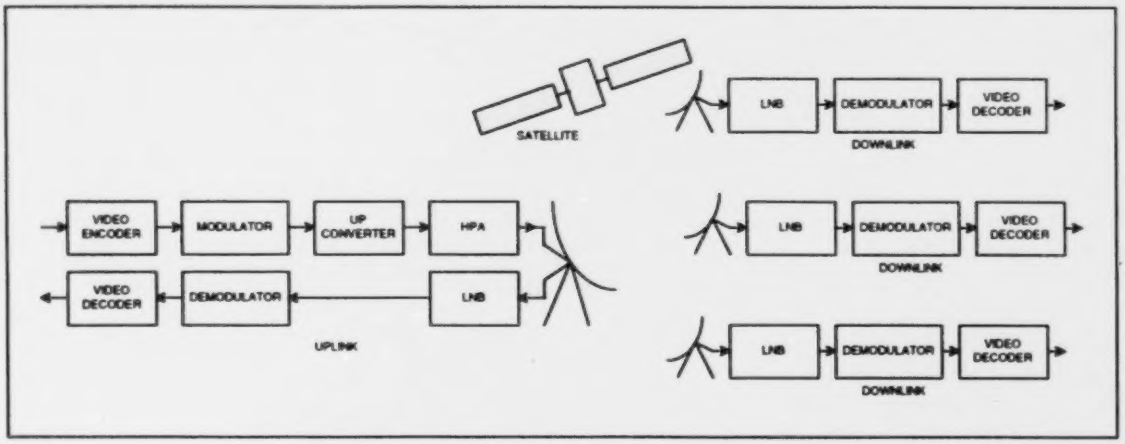

FIGURE 1. DIGITAL VIDEO DISTRIBUTION MODEL

The video encoder passes the compressed data stream to the modulator. This is the initial step in transmission of the digital data stream. The digital modulator transforms the signal using two methods that are crucial to capacity: modulation and forward error correction (FEC). These two items have a major impact on the bandwidth of the transmitted signal and the power required for transmission. In subsequent paragraphs, these items are examined from a system designer's perspective, because decisions made regarding these ultimately drive the business case; therefore, careful evaluation of the application and goals is imperative.

After modulation, the signal passes through an up converter and a high-power amplifier (HPA). The up converter translates the signal to the operating frequency of the satellite, while the amplifier boosts the signal's power level for transmission. There is a cost tradeoff between the HPA and the uplink antenna that determines the right balance of size and performance for these two elements.

A transponder in the satellite receives the transmitted digital video signal, amplifies it, and sends it back to earth. The illumination pattern that the satellite projects on the ground is an important factor in the transmission of the digital signal, and it is specified as the effective isotropic radiated power (EIRP). The other satellite parameter is bandwidth, which may range from 24 to 36 MHz, 54 or 72 MHz, or some other bandwidth.

At the downlink, the receive antenna captures the video carrier and passes it to a low noise block converter (LNB), which translates the carrier to the input of the demodulator. The antenna size, ambient noise, and the LNB set an important figure of merit for the downlink, known as the G/T ratio, which is the ratio of the gain of the receive antenna to the noise temperature of the receive system. The gain of the antenna is proportional to its size, so a larger antenna produces a higher G/T ratio, and this translates into less power required from the satellite transponder.

The demodulator completes the transmission link and transforms the carrier back into a digital data stream. The combination of the modulator and demodulator determine a major part of the link performance, so any scheme that reduces the drain on the satellite's power and bandwidth resources is worth considering. Finally, the data is delivered to the video decoder, where it is transformed back to a video signal in either analog or a digital format before continuing to its ultimate destination.

3.1 LINK PARAMETERS - POWER

One of the tools used to estimate the power requirements for satellite transmission is the link budget. This is introduced only to show the key items, not to perform a detail analysis, which can include many other factors that influence performance.

As a first cut, the downlink analysis for a system is described in Table 1.

There is a similar analysis performed for the uplink, plus additional calculations for other effects, but this is a good starting point for getting a picture of performance and limitations. The idea is not so much to perfect the link analysis as to examine the items that affect link performance. This analysis will prove useful later, when decisions about tradeoffs must be made.

The top half of the link calculation results in the C/No, a basic quantity of the link. The bottom half subtracts two terms to give the data rate, in dB, that the link supports.

The following comments on each of these terms gives an idea of what they are, and some possible changes to achieve different types of performance.

EIRP	The more power available from the satellite transponder, the higher the supported data rate. If two transponders are rated with the same saturated EIRP (or EIRPsat), the one with a solid-state power amplifier usually provides more available EIRP than the one with a tube-type amplifier.
DL_Loss	In one sense DL_Loss is fixed once the earth station location and operating frequency are established.
Fade	Rain fade at Ku and higher frequencies can have quite an impact in rainier locations. The amount of rain fade allocated affects the availability of service. Making the allowance too large reduces the allowed throughput. Making it too small permits more frequent outages.
G/T	Increasing G/T ultimately increases C/No and increases the maximum data rate through the satellite.
k	Boltzman's constant, it is fixed.
C/No	This is the total carrier power to the system noise in a 1 Hz bandwidth. C/No is the sum of the terms above the line in the top half of the equation.

A satellite with a higher available EIRP has advantages. Every increase in dB increases the C/No and throughput.

A parameter under direct user control is the G/T, which is increased by using a larger antenna or reducing the noise temperature. Usually, some improvement in G/T is possible by reducing the noise temperature with a different LNB, but the greatest change is achieved when the size of the antenna is increased.

TABLE 1. DOWNLINK ANALYSIS

+ EIRP	dBW	Usable Power From Satellite
- DL_loss	dB	Downlink Pathloss, Satellite To Rx Earth Terminal
Fade	dB	Additional Loss Due To Rain Or Other Impairment
+ G/T	dB/°K	System Gain To Temperature Ratio
- k	dBW/K-Hz	Boltzman's Constant
+ C/No	dBW-Hz	Carrier To Noise Ratio
- Eb/No_req	dB	Eb/No required to achieve BER
-Margin	dB	Desired Margin
DR_dB	dB	Data Rate From Encoder Into Modulator in dB

For the lower half of the link budget, the following terms apply:

Eb/No	The signal to noise ratio measure (energy per bit in 1 Hz noise bandwidth) used to compare the performance of modems and the link. The bit error rate (BER) is the number of errors divided by the total number of bits in a test. The lower the Eb/No is for a given BER, the less power is needed to obtain system performance.
Margin	A system parameter chosen to provide a level of safety or to maintain the system above the operating point.
DR_dB	This is the remaining quantity once the Eb/No and Margin are subtracted from the C/No. Taking the anti-log gives the data rate.

Eb/No and the Margin are subtracted from the C/No to obtain the data rate in dB (DR_dB). Notice that DR_dB is really a measure of capacity, and the higher it is the greater capacity or data rate the link supports, and the more program material it can carry.

This also reveals the importance of Eb/No in the link. The lower it is, for the same BER, the greater possible capacity through a satellite.

One way of gauging the maximum possible capacity through the satellite link is shown in Figure 2. The size of the receive antenna is allowed to vary, permitting the G/T to change. The available satellite power and an operating Eb/No are selected, and the other parameters in the link calculation are held constant. The cases shown are fairly typical for C-Band and Ku-Band satellites. An extra case is presented for Ku-Band to illustrate effects of an 8 dB rain fade, because this frequency band is much more susceptible to the effects of rain than C-Band. Some caution is warranted using this plot, because it assumes a particular set of conditions; so it does not apply to every situation. In addition, this figure does not indicate when the bandwidth of the transmitted signal may limit the maximum data rate through the satellite link.

Because of their influence on power, the modulation and coding in the modem become crucial. Today's modems employ sophisticated coding schemes to correct errors and reduce the amount of power needed to operate reliably.

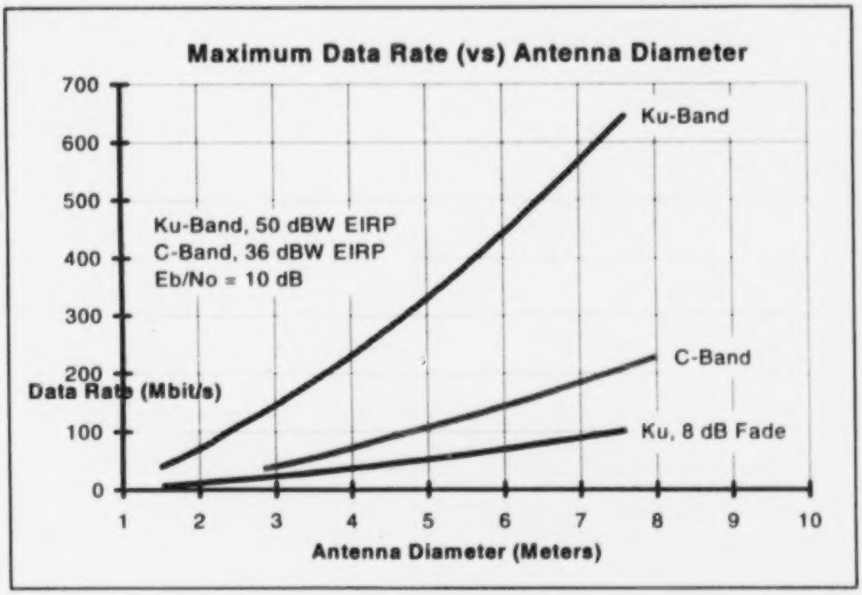

FIGURE 2. MAXIMUM COMPOSITE DATA RATE (VS) ANTENNA DIAMETER

Techniques used to reduce Eb/No requirement consist of two coding schemes operating in tandem, known as concatenated coding. The first type is Reed-Solomon, which is particularly effective at correcting bursts of errors. Reed-Solomon coding is also used in CD-ROM systems, where errors tend to be bursty.

The second type of coding is a convolutional or trellis-type coding using the Viterbi algorithm. This error correction scheme is most effective when the error environment is Gaussian (white noise) rather than bursty. The satellite channel is modeled as a Gaussian channel so the Viterbi decoder is used to correct errors produced by the demodulator. The Viterbi decoder tends to make errors in bursts, so the Reed-Solomon decoder is placed after it to clean up the burst errors—an effective combination.

Coding is usually expressed as a fraction (1/2), indicating the number of bits into the encoder versus the number of coded bits exiting the coder. Common code rates for Viterbi coding are 1/2, 2/3, 3/4, 7/8, and others. Reed-Solomon codes are based on appending error correction code words to the end of the data block, and have code rates like 188/204. The principle is the same.

In addition to the coding, the modulation should be considered. Among the common modulation techniques employed are BPSK, QPSK, 8PSK, and 16QAM. In QPSK modulation the incoming bit stream is mapped to one of four phase states, while 8PSK maps them to one of eight phase states. 16QAM modulation maps the incoming stream into one of 16 states; but in this case, the states consist of both phase and amplitude. A characteristic of these is that, as the modulation is altered from QPSK to 8PSK to 16QAM, each one requires progressively more power (Eb/No) to produce the same BER performance. Although this appears to be a drawback, there are benefits to the reduced bandwidth that make the tradeoff worthwhile.

Several modulation and coding schemes are compared in Figure 3. This shows the Eb/No required to produce a BER of 10^{-10} for each modulation and coding combination. This illustrates the effect that higher order 8PSK and 16QAM systems require progressively more power than QPSK. What is not evident is the tremendous improvement all these coded systems have over uncoded systems.

3.2 BANDWIDTH

If power were the only consideration, then it would only be necessary to select the modulation and coding technique that produces the minimum Eb/No at the performance point.

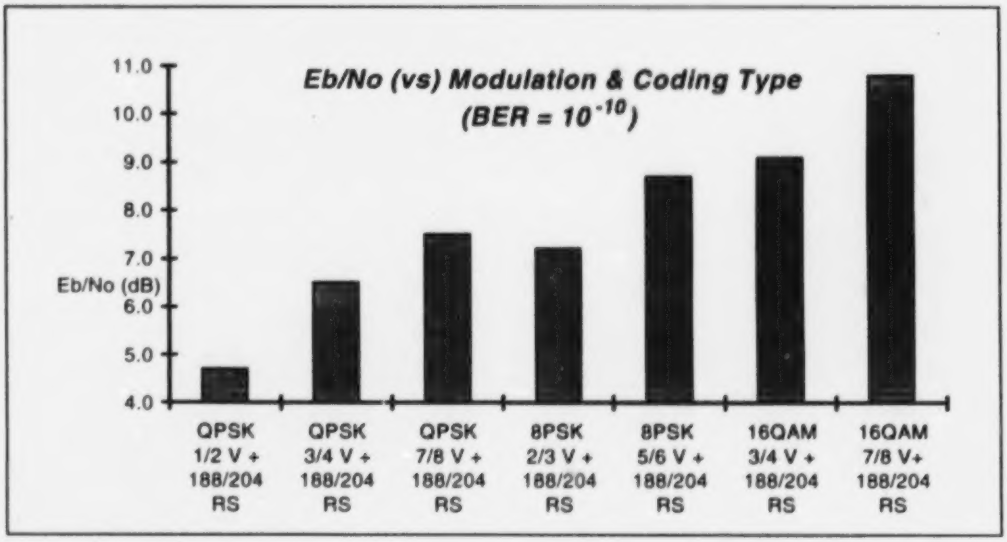

FIGURE 3. Eb/No (VS) MODULATION AND CODING TYPE AT BER = 10^{-10}

However, bandwidth is also a key resource, so tradeoffs affecting it are considered as well.

The occupied or radiated 3 dB bandwidth for this class of digital modulation is symbol rate (SR). This quantity is easily calculated and is based upon both the order of the modulation and the code rate. BPSK, QPSK, 8PSK, and 16QAM modulation types all produce 2^m output states, where "m" is the number of bits mapped into a symbol. A larger value of "m" corresponds to a higher order of the modulation, and the bandwidth of the transmitted signal is reduced by a factor of:

$$\frac{1}{m}$$

Higher order modulation schemes are often referred to as bandwidth efficient. For several common forms of modulation, the following table lists the bandwidth efficiency:

Modulation Type	m	Number Of States (2^m)	Relative Bandwidth
BPSK	1	2	100%
QPSK	2	4	50
8PSK	3	8	33
16PSK	4	16	25
16QAM	4	16	25

Previously, the beneficial effects of error correction coding were examined. The ability to reduce the required power from the satellite is not without some penalty. There is extra information added to the original data stream that aids the error correction process, and this increases the radiated bandwidth of the video carrier. To quantify, the Viterbi code rate is referred to as CRv, while the Reed-Solomon code rate is designated CRr. The impact coding has on bandwidth is proportional to the following:

$$\frac{1}{CRv \times CRr}$$

There is now enough information to calculate the symbol rate:

$$SR = \frac{DR}{m \times CRv \times CRr}$$

Where:

SR = Symbol Rate
DR = Data Rate
m = Modulation factor
CRv = Code Rate, Viterbi
CRr = Code Rate, Reed-Solomon

The effect on bandwidth is more dramatically illustrated in Figure 4, which shows the relative bandwidth for each modulation and code type.

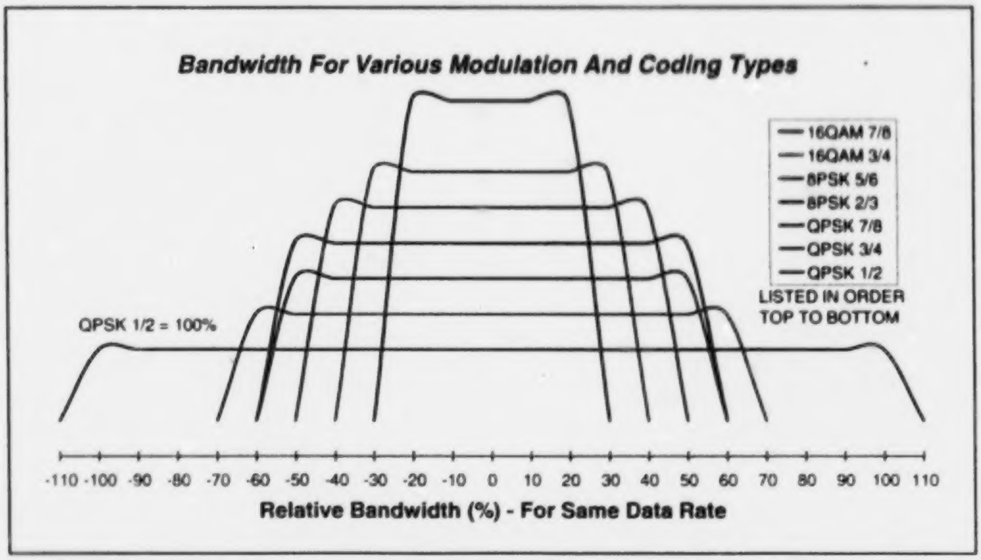

FIGURE 4. RELATIVE BANDWIDTH (VS) MODULATION AND CODING TYPE

The figure is plotted for the same data rate in all cases, with the modulation and coding combinations normalized to the QPSK R1/2 case, which is set to 100%. Observe that a QPSK R3/4 carrier occupies approximately 65% of the bandwidth required by a QPSK R1/2, while for the same data rate, the required bandwidth shrinks to a mere 28% with 16QAM R7/8. For this illustration, the Reed-Solomon code rate is held constant. It is important to reiterate that the improvement in bandwidth efficiency for the higher order modulation schemes is offset by an increase in power to achieve a given level of performance. Conversely, the improvement in power efficiency afforded by forward error coding is at the expense of bandwidth. Within this context, system technical tradeoffs are made to meet the needs of the business.

3.3 SYSTEM TRADEOFFS

Two applications are reviewed briefly to show how different goals drive system choices in contrasting directions. The first system is distribution of broadcast programming to network affiliates, and the second is direct-to-home television distribution. First, a comparison of the goals is listed in the following table.

Item	Network Broadcast	Direct To Home
Rx Antenna	4.5 to 7.3 meter	0.5 meter
Material	4:2:2 Contribution	4:2:0 Distribution
Quality	Very High	Good
System/ Customer	Professional	Consumer
Quantity	100s	> 10 million
Satellite Band	C-Band	Ku-Band (DBS)
Availability	Very High	Moderate
Program Edit	Pre and Post	Insert
Eb/No + Margin	11.7	9.8

In both cases, maximum capacity is desired, but the available elements in each system are different. A summary of some key system tradeoffs is shown in the following table.

Parameter	Network Broadcast	Direct To Home
Rx G/T	24 dB/K	12.5 dB/K
Satellite Transponder	36 MHz	24 MHz
Satellite EIRP	35 dBW (C-Band)	50 dBW (Ku-Band)
Data Rate	66 Mbit/s	24.5 Mbit/s
Modulation, Coding	8PSK, R5/6 & RS	QPSK R2/3 & RS
Tx Bandwidth (3 dB)	28.6 MHz	20.0 MHz

Note: RS = Reed-Solomon, CRr = 188/204

In direct-to-home applications, a small antenna is needed to meet cost goals and comply with local ordinances. Combining the small size with the available EIRP (50 dBW) leads to the selection of two systems parameters: the use of Ku-Band frequencies for a smaller antenna, and a lower data rate (24.5 Mbit/s) because of a lower G/T.

The lower data rate consumes less bandwidth than a standard 36 MHz transponder, and this permits the deployment of a narrower 24 MHz bandwidth transponder. Although the capacity per transponder is lower, some capacity is reclaimed because more 24 MHz transponders fit within 500 MHz than 36 MHz transponders. In this application, the receive antenna is so small that the spacing between satellites for direct-to-home is 9 degrees instead of the usual 2 degrees. To avoid interference from the satellites already in orbit at 2 degrees, the frequency plan of the direct-to-home satellites is also somewhat higher than the existing satellites.

By contrast, the broadcast distribution model with its substantially higher G/T supports a higher data rate, but only if the bandwidth of the signal does not overfill the transponder. If the same QSPK modulation selected for the direct-to-home application is attempted, then the maximum data rate is only 37 Mbit/s through the 36 MHz transponder. This is roughly half the 66 Mbit/s throughput possible by taking advantage of the larger antenna and the narrower bandwidth consumed by 8PSK. The reasons for making the system tradeoffs are compelling.

3.4 TEST RESULTS

Although bench testing of modems back-to-back is necessary as a starting point, nothing tests the proof of a concept like testing over a satellite transponder. A satellite test includes all of the transmission impairments due to bandwidth restrictions and non-linearities in the ground equipment and the satellite. It also includes the degradation caused by adjacent channel interference (ACI) and cross-polarization interference (CPI), and in the case of multi-carrier operation, the degradation due to intermodulation between the carriers.

3.4.1 TWO 34 MBIT/S CARRIERS

Tests were conducted to verify whether two digital component video signals could be successfully transferred over a 36 MHz transponder. The video encoder/decoder were based upon the ETS 300 174 standard, which is capable of operating at either 34.368 Mbit/s (E3) or 44.736 Mbit/s (T3/DS3). In this application, the video programming originates from a number of sites that share a single transponder, so combining the streams into a single composite was not a consideration.

Figure 5 shows a block diagram of the setup for the test. In the test, both carriers were originated from the same earth station. Additional studio equipment (including taped source material, digital tape recorders, studio monitors, and other equipment) was on site to evaluate the video quality, but these are not shown as part of the transmission diagram. The tests conducted over the satellite demonstrated a viable link using 8PSK R5/6 modulation. The following table lists some of the link parameters and results.

Parameter	Description
Required EIRP per Carrier	32 dBW (C-Band)
Total EIRP for 2 Carriers	35 dBW
Satellite Backoff from 1 dB Compression (38 dBW)	[1] 3 dB
Down Link G/T	24 dB/K
Operating Eb/No /Margin	11.8 dB /1.9
Modulation and Coding	[2] 8PSK R5/6, no Reed-Solomon
Symbol Rate Bandwidth (3 dB)	13.7 MHz
Carrier Spacing	[3] 16 MHz
Video Quality /Standard	4:2:2 /ETS 300 174
Program Concatenations	3 excellent quality, 5 with minimal degradation

Notes:

1. Separate testing on the satellite simulator indicated no degradation at a backoff of 1.25 dB for 8PSK and 2 dB for 16QAM.
2. Reed-Solomon coding is implemented in

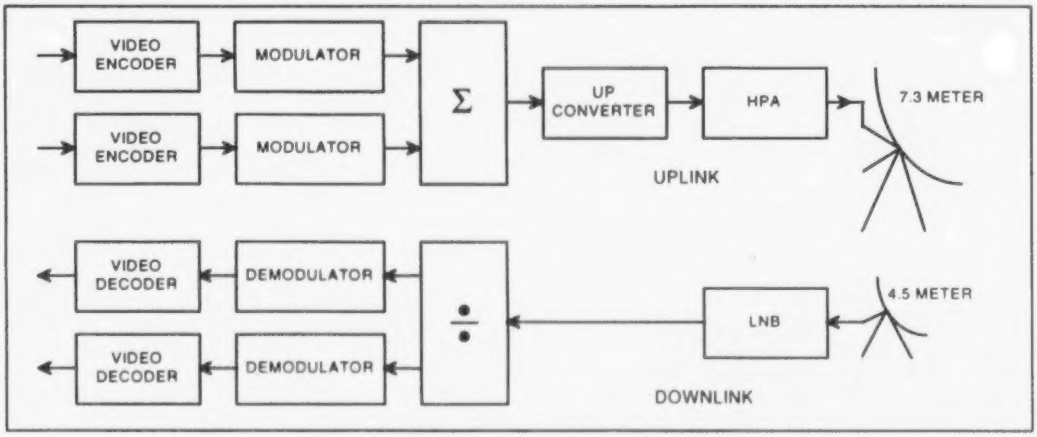

FIGURE 5. MULTICARRIER TEST SETUP

the video decoder. Two levels of Reed-Solomon provide no improvement in performance. Without the Reed-Solomon coding stage, the radiated bandwidth is smaller.

3. See text.

Carrier spacing is a key issue, and the general problem to address is shown in Figure 6. The carriers are moved apart to minimize the interference caused by spectral overlap.

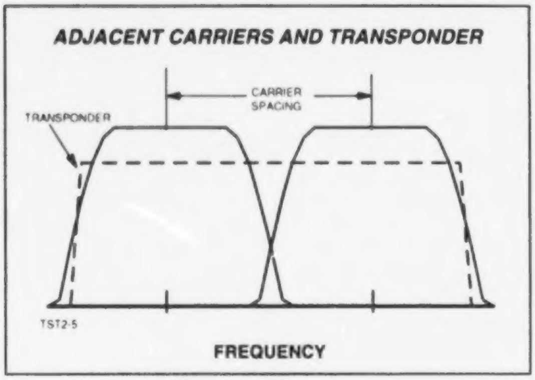

FIGURE 6. CARRIER SPACING

As this continues, the edges of the transmitted spectrum experience distortion as they encroach on the band edges of the transponder.

Combating transponder edges by moving the carriers closer together will eventually return them to the point where they interfere with one another again. Empirical testing was undertaken to locate the optimal spot or the best compromise between these sources of degradation. The best spacing between the carriers was found at 17 MHz separation.

Additional bench testing of the same system with a satellite simulator (flight hardware in a ground test station) was performed with 16QAM at R3/4 + Reed-Solomon. Carrier spacing is not an issue because the symbol rate bandwidth of the 16QAM carrier (12.4 MHz) is sufficiently narrow so that both carriers fit comfortably in the transponder. Performance of the 16QAM system was very good, and margin, with this setup, was virtually identical to the 8PSK case.

3.4.2 TWO 44.736 MBIT/S CARRIERS

Testing was performed over satellite with two 44.736 Mbit/s (T3) carriers using 16QAM and R7/8 + Reed-Solomon coding. The test results varied considerably, with good results in some cases and marginal performance in others.

Testing and implementation of links with 16QAM is a fertile area for additional investigation. Clearly, this modulation scheme is more sensitive to the non-linearities of components in the link, and greater care is required to successfully implement a clean link.

To date, a number of the 16QAM links were put together and tried, but more work is needed to methodically check performance by characterizing each of the functional blocks of the link, and performing loop tests at critical junctures.

4. SUMMARY

Tradeoffs for transmission over a satellite link were presented. Along with this, calculations were introduced showing what is involved in establishing a link budget, and how the main elements of the link affect performance. The modem has a strong impact on the performance of the link and power requirements (E_b/N_0) and radiated bandwidth.

Several modulation and coding choices were discussed. System tradeoffs for a broadcast network and direct-to-home transmission were compared, along with their different goals. Test results for 8PSK and 16QAM transmission were presented for systems transmitting total composite data rates of 68 to 90 Mbit/s through a 36 MHz transponder.

A Hybrid FDMA/TDM Network Using ACTS

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ABSTRACT

On-board processing satellite systems enable the use of mixed-access architectures, including a hybrid of FDMA uplink and TDM downlink. The first on-orbit demonstration of such an FDMA/TDM architecture, as well as the advantages of this approach, are described in this paper.

1. OVERVIEW

NASA's Advanced Communication Technology Satellite (ACTS) has experimentally demonstrated the advantages of on-board processing, including signal regeneration and switching, for satellite network efficiency and flexibility.

However, ACTS is designed as a time division multiple access (TDMA) system, which has some negative implications for the earth station. In particular, each earth station is required to transmit data bursts at a much higher rate than the user data rate, which requires a larger antenna and/or a more powerful transmit amplifier than would be needed in a non-TDMA system. Since one of the large cost drivers for an earth station at Ka-band is the high power amplifier, and since this cost is repeated many times throughout the network, a TDMA architecture is relatively expensive for a large operational satellite network.

With the development of bulk demodulators, it is now possible for satellite networks to be designed with a more traditional frequency division multiple access (FDMA) scheme on the uplink, while still making use of on-board processing and time division multiplexing (TDM) on the downlink. This hybrid FDMA/TDM architecture has all the advantages of on-board processing, as well as low cost earth stations.

The hybrid FDMA/TDM architecture is attractive for future satellite systems, but has not yet been demonstrated on-orbit. ACTS, though designed as a pure TDMA system, can demonstrate this network architecture using two uplink frequencies at high data rates. This paper describes an ACTS network based on these concepts, and discusses the scalability of the network from a small number of high data rate earth stations to a large number of lower speed earth stations.

2. INTRODUCTION

The Advanced Communication Technology Satellite (ACTS), developed by the National Aeronautics and Space Administration's (NASA) Lewis Research Center, has been highly successful in its goal of demonstrating new technologies for satellite communications. Among these technologies was the use of Ka-band frequencies (30 Ghz uplink and 20 Ghz downlink), the use of an on-board baseband processor, and a multiple spot beam antenna. Baseband processing, working together with the spot beam antenna, greatly enhances network efficiency and flexibility. The baseband processor receives uplinked signals, demodulates them, routes them to their proper destination spot beam, and retransmits them to the destination earth station.

Indicative of the success of ACTS, fourteen filings, including refs. (1)-(7), have been submitted to the U.S. Federal Communications Commission requesting permission to build and launch future satellite communication systems using ACTS technologies. The flight demonstration of the ACTS baseband processor has been cited as a significant risk reduction by several of the companies planning these future satellite systems. However, the time division multiple access (TDMA) scheme used on ACTS has some significant disadvantages for operational satellite networks. Most of the on-board processing systems which have been proposed plan to use a hybrid multiple access scheme, using conventional frequency division multiple access (FDMA) for the uplink, and time division multiplexing (TDM) for the downlink. This type of system architecture has not yet been demonstrated in orbit by any system. This paper describes how ACTS can be used to model such a system in the first demonstration of a hybrid FDMA/TDM satellite network architecture.

3. ACTS DESIGN ARCHITECTURE

3.1 ON-BOARD PROCESSING

The use of on-board processing has great advantages for link improvement and network efficiency . Because the signal is demodulated at the satellite, it is regenerated to a noise-free digital signal before retransmission to earth. This has the effect of decoupling uplink noise from downlink noise, resulting in approximately 3 dB improvement (8).

More importantly, the use of on-board processing enables demand-assigned multiple access (DAMA), and individual user addressing. This allows capacity to be allocated only when needed, and allows downlink power to be directed to those users engaged in communication, so the satellite power is used efficiently. For pairs of earth stations each offering 1 Erlang of traffic, DAMA increases the system capacity by a factor of four (8) as compared with a conventional bent pipe architecture, in which transponder bandwidth is leased on a full time basis. For lighter load users, this multiplication increases.

Furthermore, conventional satellites have a large antenna footprint, so the downlink power is spread over the entire continent. This type of footprint is needed for broadcasting, but for point to point communications this represents an inefficient use of spacecraft transmitter power. Using spot beams with on-board processing provides an improvement of up to three times the capacity per pound of spacecraft weight on orbit (9). The footprints of the ACTS multibeam antennas are shown in Figure 1.

The use of on-board processing increases the complexity of the spacecraft as compared with bent pipe systems, but the increased efficiency of the satellite and the ability for users to access bandwidth on demand and pay only for actual usage of capacity more than offset the increase in cost for the end user. Moreover, reliability concerns about the complexity of an on-board processor have been put to rest by operational experience with the ACTS baseband processor, which has not experienced any failures through two years on orbit and 16,000 hours of operation (10).

3.2 TDMA

The implementation of baseband processing on board the satellite makes it necessary to demodulate the data uplinks from all the users in the network, a sizable number even in an experimental network. When ACTS was designed, the most cost-effective means of accomplishing this was to use TDMA for both uplink and downlink. By using TDMA, the on-board processor is only required to demodulate one uplink carrier, then demultiplex the resulting data stream to separate the users. ACTS was designed using a 110 Mbps burst rate with TDMA for both uplink and downlink. In addition to the 110 Mbps burst rate, the ACTS baseband processor system also can demodulate two uplink signals at 27.5 Mbps, at frequencies designated C6 and C7 (11), as depicted in Figure 2.

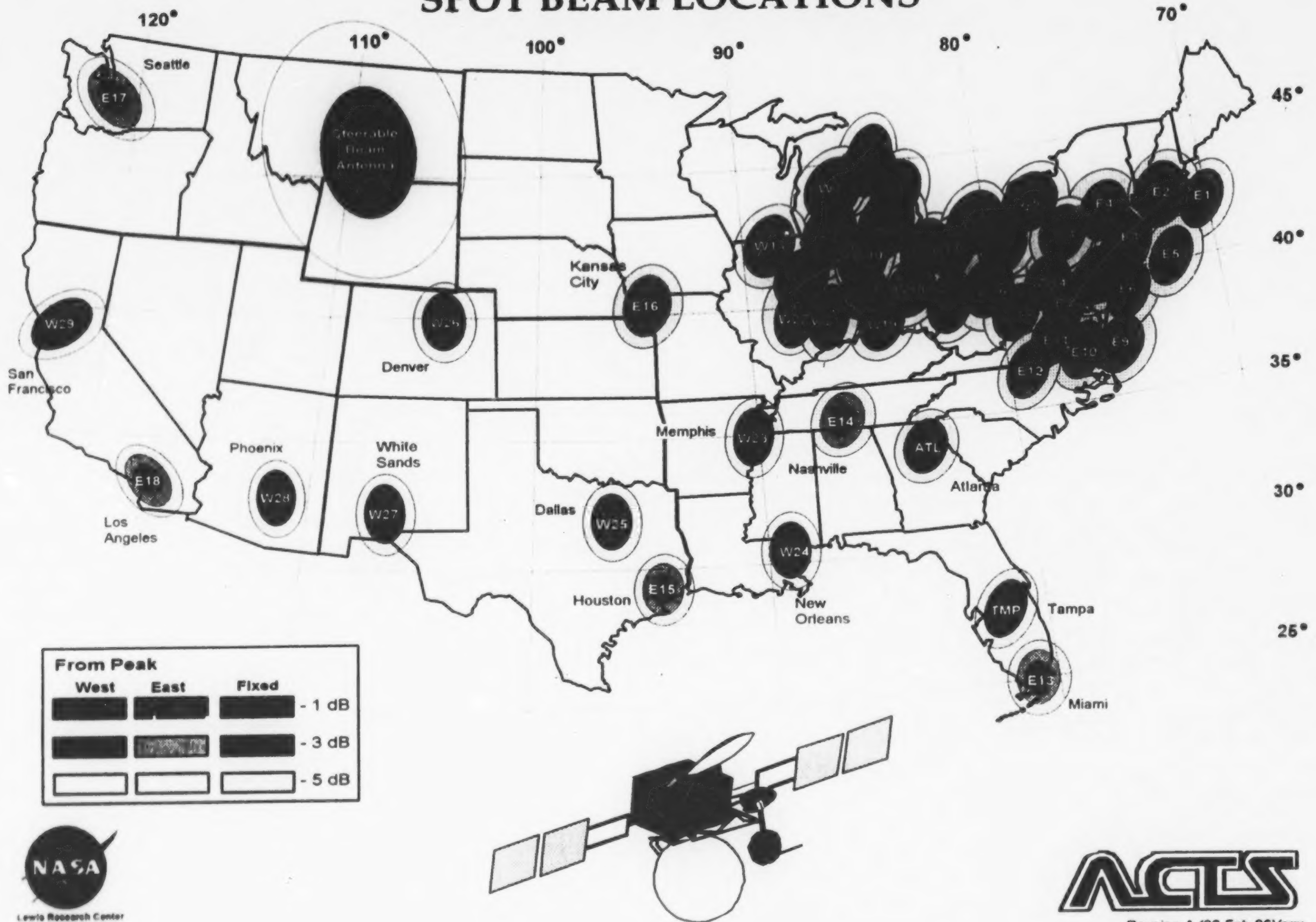
The pure TDMA approach minimizes complexity on the satellite, saving weight and power, but it places a large cost burden on the earth stations, for two reasons. First, in a TDMA system, the earth station must have a very precise timing source in order to stay synchronized with the network. In addition, the earth station is required to have enough uplink power to complete a link with sufficient margin in signal power at a high data rate, while the available user data rate is much lower. The effect is to drive up the earth station cost because large antennas and high powered uplink amplifiers are required. For example, in the ACTS T1 Very Small Aperture Terminal (VSAT), shown in figure 3, the high power amplifier (HPA) output is 12 W at the feed in order to support a burst rate of 27.5 Mbps, but the user bandwidth is only 1.792 Mbps (12).

4.0 HYBRID FDMA/TDM

To date, the only on-board processing networks which have been demonstrated in orbit are based on TDMA network architectures. But the development of on-board multicarrier demodulators allows spacecraft designers to re-examine the question of which multiple access scheme to choose. FDMA is now a viable option with on-board processing, as are multi-frequency TDMA (MF-TDMA), code division multiple access (CDMA), and others. Of the various uplink multiple access schemes, FDMA is the simplest and least expensive to implement in the earth station (13). It provides full bandwidth utilization for the user, allowing the earth station throughput to equal the modulated signal bandwidth.

FIGURE 1

SPOT BEAM LOCATIONS


120°
110°
100°
90°
80°
70°
45°
40°
35°
30°
25°
Seattle
E17
Steerable Beam Antenna
Kansas City
E16
W15
W29
San Francisco
W26
Denver
Memphis
W23
E14
Nashville
ATL
Atlanta
Phoenix
W28
White Sands
W27
E18
Los Angeles
Dallas
W25
W24
New Orleans
E15
Houston
TMP
Tampa
E13
Miami
E1
E2
E3
E5
E9
E10
E12
From Peak
West
East
Fixed
- 1 dB
- 3 dB
- 5 dB

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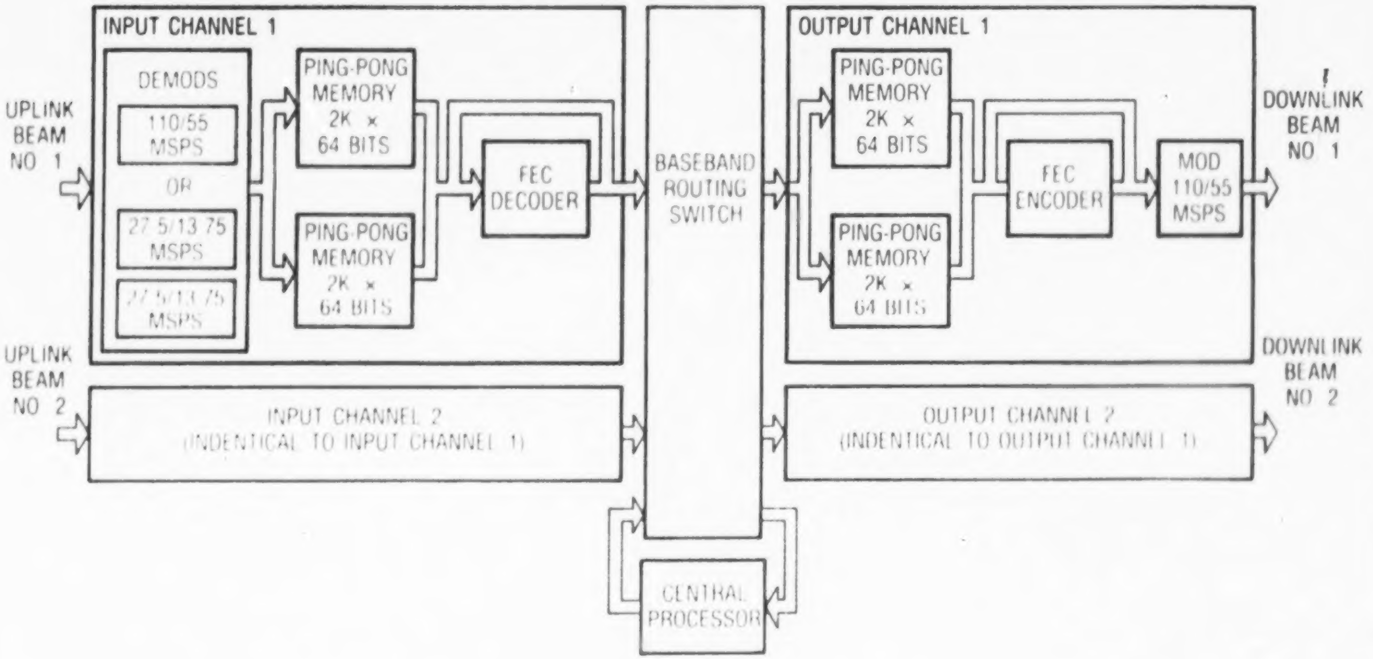
C-88-00562

FIGURE 2

BASEBAND PROCESSOR SYSTEM


INPUT CHANNEL 1
UPLINK BEAM NO 1
DEMODS
110/55 MSPS
OR
27.5/13.75 MSPS
27.5/13.75 MSPS
PING-PONG MEMORY 2K × 64 BITS
PING-PONG MEMORY 2K × 64 BITS
FEC DECODER
BASEBAND ROUTING SWITCH
OUTPUT CHANNEL 1
PING-PONG MEMORY 2K × 64 BITS
PING-PONG MEMORY 2K × 64 BITS
FEC ENCODER
MOD 110/55 MSPS
DOWNLINK BEAM NO 1
UPLINK BEAM NO 2
INPUT CHANNEL 2 (INDENTICAL TO INPUT CHANNEL 1)
OUTPUT CHANNEL 2 (INDENTICAL TO OUTPUT CHANNEL 1)
DOWNLINK BEAM NO 2
CENTRAL PROCESSOR

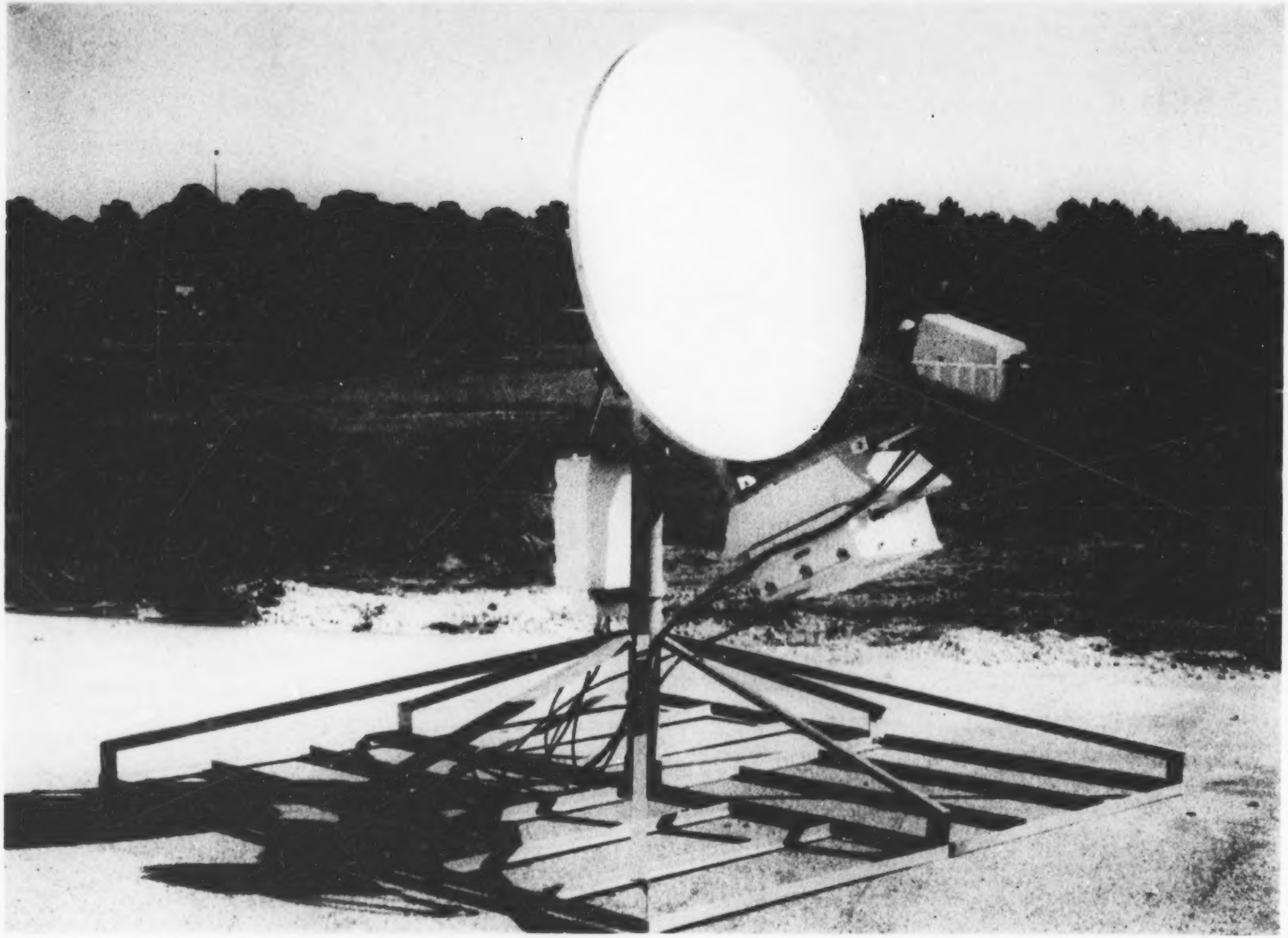


FIGURE 3. ACTS T1 VSAT

Furthermore, on-board processing enables different uplink and downlink multiple access schemes. TDM is advantageous for the downlink, because it permits single carrier per transponder operation, which allows the downlink traveling wave tube amplifiers (TWTA) to operate at saturation, avoiding the 4 to 5 dB power backoff which is normally required when downlinking multiple carriers.

Use of FDMA on the uplink and TDM on the downlink provides all the benefits of a baseband processing system, as well as low cost earth stations. Signal regeneration and on-board switching can still be accomplished, providing improved signal quality and network efficiency over conventional FDMA bent pipe systems. But in addition, the earth station is relieved of the precise timing requirement and the high speed burst requirement imposed by a TDMA processing satellite (14). An FDMA/TDM hybrid system may still require earth station synchronization, depending on the design of the multicarrier demodulator (13), but the earth stations are synchronized at the much lower user data rate, rather than the high burst rate. This less stringent synchronization can be accomplished much less expensively than is required in a pure TDMA system.

In addition to the relaxed timing requirement, the earth station transmit power requirement is greatly reduced. In an FDMA/TDM hybrid system, the antenna size is determined by the downlink link budget calculation. For example, the ACTS baseband processor network uses a 1.2 m antenna, which has a 46 dB gain at 20 GHz, to receive the 110 Mbps downlink with adequate margin. In an FDMA/TDM system, the HPA can then be sized to support a much lower speed uplink, with the high antenna gain (49 dB at 30 GHz) resulting from the size of the antenna required by the downlink. This architecture reduces the HPA size from the high power levels which require TWTA's to lower power levels which can be supported by much less expensive solid state power amplifiers (SSPA).

5.0 ACTS MODEL OF HYBRID FDMA/TDM SYSTEM

ACTS, though designed as a pure TDMA system, can demonstrate the FDMA/TDM network architecture using two uplink frequencies at high data rates. By allocating all of the TDMA frame to a single 27.5 Mbps earth station on each of the uplink frequencies (i.e. C6 and C7), a two-level FDMA uplink is achieved. The ACTS downlink is always Time Division Multiplexed (TDM), so use of FDMA uplink represents a hybrid FDMA/TDM satellite network architecture. Each user terminal is allocated a 27.5 Mbps uplink and a time division multiplexed 110 Mbps downlink. ACTS includes two scanning beam families, designated East and West. By assigning frequencies C6 and C7 to users in each of the scanning beam families, a maximum of four earth stations can be supported. Traffic can be routed to any of these earth stations in full mesh operation, as depicted in Figure 4.

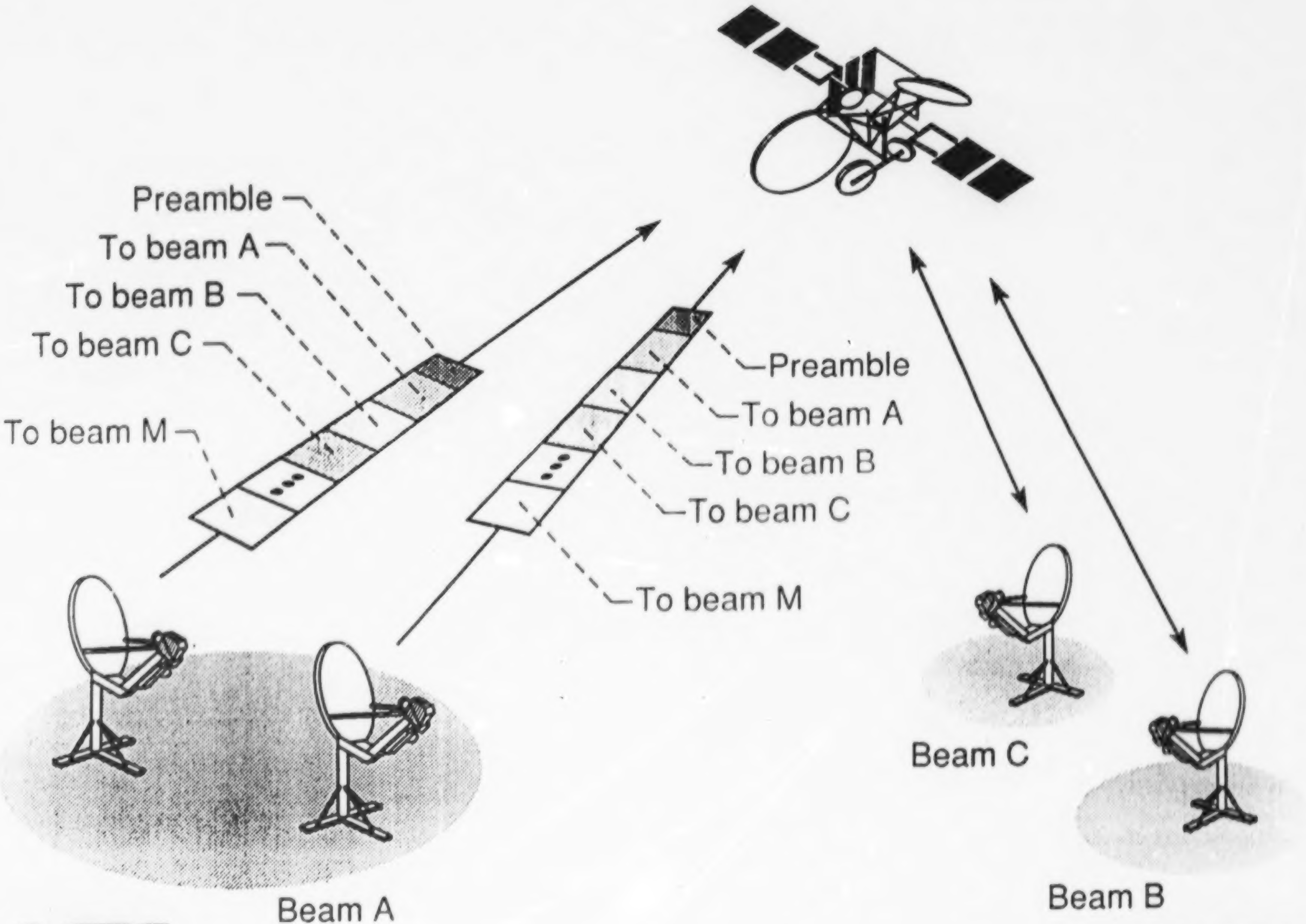
Because ACTS is designed as a circuit-switched TDMA system, a certain portion of the frame is allocated for earth station acquisition, orderwire messages, etc. This overhead requirement will nominally reduce the user data rate from the 27.5 Mbps burst rate to 24.128 Mbps. A user data rate of this magnitude using a 1.2 m antenna far surpasses any capability achievable with conventional bent pipe satellites.

Initial experimentation will verify that ACTS, with the High Speed VSAT (a modified version of the T1 VSAT), can provide high speed data traffic to a single earth station with a very small aperture. Secondly, testing will determine that ACTS can simultaneously demodulate high speed data from multiple carriers. The ACTS baseband processor will then be used to accept incoming data from multiple uplinks, format it into multiple TDM downlinks, and route it to multiple destination stations. These experiments will culminate in a full mesh of four High Speed VSATs each communicating with all of the other stations simultaneously. These tests will ensure adequate frequency isolation and spurious rejection in demodulation of multiple carriers, and will experimentally determine the maximum possible throughput of user data, minimizing all sources of overhead. The nominal value of 24 Mbps represents a throughput efficiency of 88% for the earth station, as compared with 6.5% for the ACTS T1 VSAT in TDMA mode.

6.0 SCALABILITY

An operational system using this technology will be required to serve many users, most with lower data rate requirements than those achieved in this demonstration with ACTS. In particular, several of the proposed systems (1)-(7) have identified T1 (1.544 Mbps) or fractional T1 (e.g. 384 kbps or 768

FIGURE 4. On-board Switched FDMA/TDMA.


Preamble
To beam A
To beam B
To beam C
To beam M
Preamble
To beam A
To beam B
To beam C
To beam M
Beam A
Beam C
Beam B

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kbps) as the basic service level. ACTS, as shown in Figure 2, has two 27.5 Mbps demodulators in each of its two beams, feeding uplinked data into the baseband processor switch. Proposed multicarrier modulator designs, as depicted in Figure 5, demultiplex the received signals and pass the resulting composite signal to a time-shared demodulator, which produces a digital data stream that is passed to the baseband switch. If the two ACTS demodulators were replaced by a bulk demodulator of this type, the ACTS baseband processor could support 62 simultaneous T1 circuits in each beam, assuming comparable overhead for circuit setup as with the current system. User throughput is then 95.7 Mbps per beam. With two beams on the spacecraft, the total throughput is 124 T1 circuits, or 191.4 Mbps. Changing the uplink transmission rate from 27.5 Mbps to 1.544 Mbps represents a 12.5 dB gain; this would allow the HPA to be reduced from 12 W to 1 W. Alternatively, the antenna could be reduced from 1.2 m to .6 m (when the downlink link budget supports this—primarily a function of the earth station location in the satellite spot beam), and the HPA could be reduced to 3 W. This would reduce the cost from tens of thousands of dollars for the combination of Ku-band TWTA and high power frequency doubler (HPFD), to several hundred dollars for a 1 W solid state power amplifier, built in quantity.

For comparison, the KaStar system proposes 100 T1 carriers per uplink beam, or throughput of 154 Mbps per beam. With 48 hopping beams, the total throughput of this system as proposed is greater than 7.4 Gbps(7).

The operational system design, when compared with ACTS, proposes a greater number of FDMA uplink channels, and a much larger number of hopping spot beams to be processed on board. Still, the KaStar architecture is comparable in per-beam capacity to the ACTS hybrid FDMA/TDM system, as are those proposed by other on-board processing systems being planned. Thus, no major technology developments are required for the on-board processor to be scaled to a large number of low speed users. The major difference between the demonstrated system and the future proposed systems is in the on-board multicarrier demodulator; switching and routing the signals after demodulation is a task very similar in scope to the processing proven by ACTS.

7.0 FDMA/TDM SATELLITE NETWORKS IN THE GII

The Global Information Infrastructure (GII) is experiencing explosive growth. As the infrastructure grows, applications of the new communications capabilities are growing just as rapidly. Satellite technology is a key element in making the information infrastructure truly global, as satellites provide the only economical means of delivering modern communications capabilities to remote and underserved areas. The key to the success of satellites at filling this role effectively is keeping down the cost to the end user.

The use of satellites in a hybrid FDMA/TDM system architecture will enable satellite network providers to offer low-cost, high speed communications capacity to users equipped with small, inexpensive earth stations, who might not otherwise be connected to the GII.

A low cost earth station capable of T1 rate communication is suitable for many applications, some of which are listed below. Many of these have been demonstrated using the ACTS satellite; others are projected markets for future systems planning to use on-board processing(1)-(7).

7.1 VOICE COMMUNICATION

In underdeveloped areas, including third world and former Eastern Bloc countries, satellites are a quick and economical method of upgrading inadequate voice communication infrastructure.

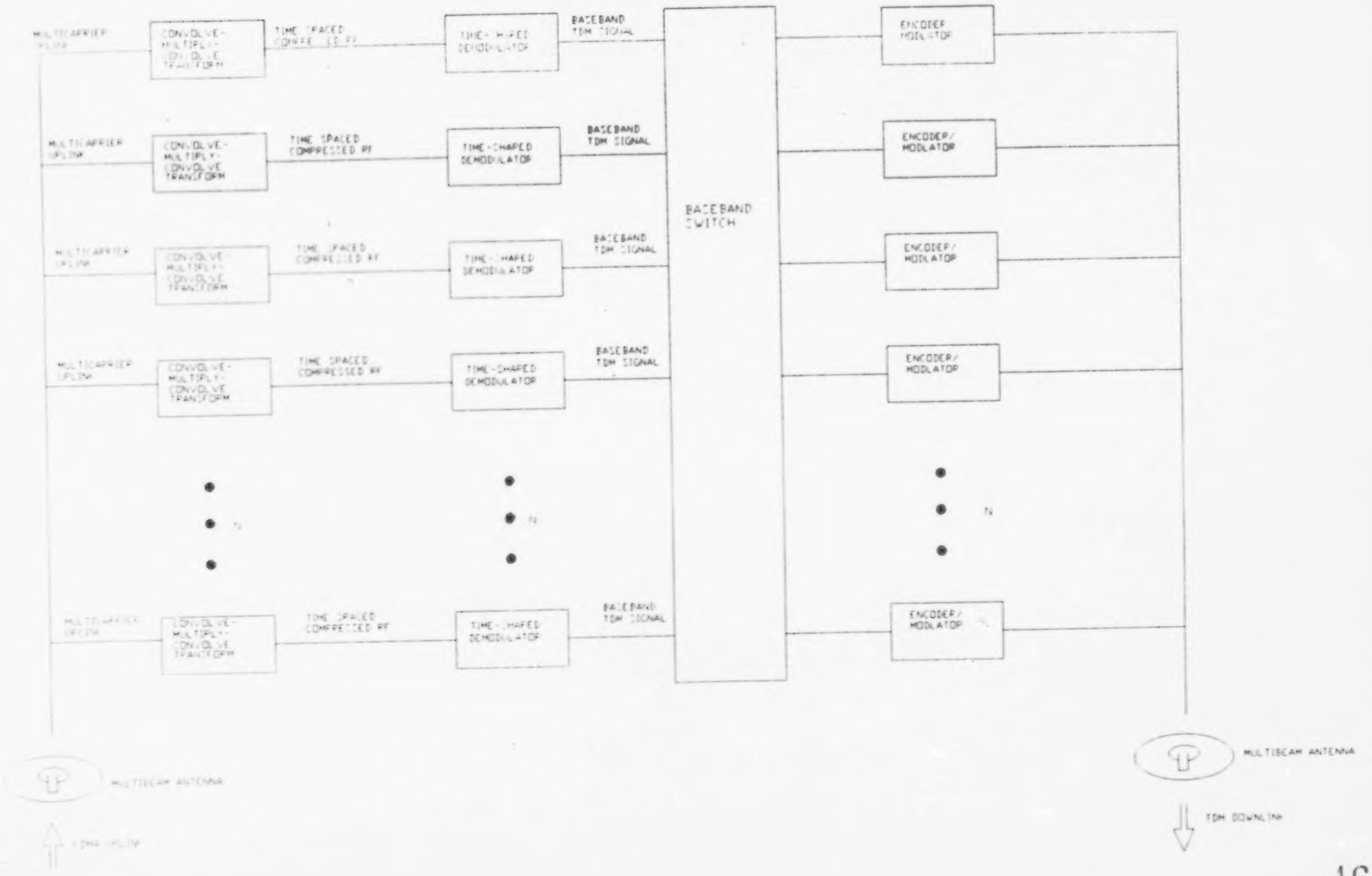
7.2 BUSINESS COMMUNICATIONS

Business networks can take full advantage of a DAMA satellite to extend their reach to remote offices and field sites. Communications requiring high-speed, low cost satellite links might include video teleconferencing with remote job sites, software distribution, LAN access for telecommuting, financial data exchange, retail point of sale data communications, relay of data such as seismic survey data for oil exploration, and remote monitoring of systems such as power transmission lines or oil pipelines.

7.3 ENTERTAINMENT

Direct to home television is already a strong and growing market for satellites. With a low cost, high bandwidth earth station capable of transmitting as well as receiving, it is possible to provide direct to

FIGURE 5. FDMA/TDM ON-BOARD PROCESSOR CONFIGURATION


MULTICARRIER UPLINK
CONVOLVE-MULTIPLY-CONVOLVE TRANSFORM
TIME SPACED COMPRESSED RF
TIME-SHAPED DEMODULATOR
BASEBAND TDM SIGNAL
BASEBAND SWITCH
ENCODER/ MODLATOR
N
N
N
MULTIBEAM ANTENNA
FDMA UPLINK
MULTIBEAM ANTENNA
TDM DOWNLINK

home, high definition interactive television and interactive video games. The baseband processor and spot beam technologies enable narrowcast programming and delivery of video on demand. Video game software can be delivered directly to a home system via satellite, and periodic updates can be provided. Small earth stations in an FDMA/TDM hybrid network can provide portable uplinks of video and CD quality audio, for delivering signals live from a concert or sporting event, for example. Interactive video and games can be delivered to cruise ships at sea or to aircraft in flight.

7.4 MILITARY

Small, portable satellite communications have myriad applications for the military, including transmission of satellite imagery, digital battlefield modeling and simulation, and conferencing with field commanders. Military satellite communications are needed from fixed sites, land vehicles, aircraft and surface ships, all of which require small antennas.

7.5 TELEMEDICINE

In remote areas, adequate medical treatment is not always available. Inexpensive satellite communications allows medical practitioners and emergency medical technicians who staff rural medical clinics, or who are present at the site of an accident, to confer and exchange medical data with specialists based at hospitals many miles away.

7.6 DISASTER RECOVERY

In the aftermath of natural disasters, basic communications are often disrupted or overloaded. Small, easily deployable satellite communications can provide interim communications for recovery operations. For businesses with significant reliance on terrestrial lines, satellites with on-demand access will provide an economical backup in case of disruption of the terrestrial connections.

7.7 NEWS GATHERING.

Journalists often require the ability to file news stories, including video, from remote locations as quickly as possible. An FDMA/TDM hybrid satellite will allow them to do so at minimal cost, using a small, portable earth station.

7.8 REMOTE SCIENTIFIC AND ENVIRONMENTAL MONITORING

Many types of scientific data must be acquired at remote field sites, and monitored over an extended period of time. Automated monitoring stations with satellite data relay capability can greatly improve the efficiency of scientific data collection.

8.0 CONCLUSIONS

Satellite communications will clearly have a role in the emerging GII. The significance of that role will depend heavily on the ability of the satellite communications industry to provide services at low cost. Many of the applications described above are viable markets for satellite communications with current technology; however, all of them will show improved growth if user costs can be minimized. The FDMA/TDM architecture promises to achieve the low costs required by these markets, by dramatically reducing earth station cost without significantly increasing space segment costs as compared with TDMA processing satellites.

The ACTS demonstration of the FDMA/TDM architecture will prove out the concept of on-board demodulation of multiple carriers, switching between multiple destinations, and formatting the data into a TDM downlink. The ACTS baseband processor will demonstrate the ability to perform frequency division to time division mapping, with a per-beam capacity comparable to those being proposed for future commercial systems. Experimentation with ACTS in the FDMA/TDM configuration will provide the first on-orbit demonstration of the feasibility of a hybrid FDMA/TDM satellite network architecture.

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Expansion of the Intelligent Network to Support Nation-wide Services: an Indonesian Perspective

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PT TELEKOMUNIKASI INDONESIA
Bandung, Indonesia

1. ABSTRACT

Indonesia is a very large archipelago with approximately seventeen thousand islands and greatly variation of population density as well as telephone density. The imbalance of the telephone density level has prompted TELKOM to increase the telephone-line penetration, while at the same time, the company faces obligation to satisfy the desires of its business customers. As global economic inclines and competitive market started to breeze, TELKOM has been seeking a technology to rapidly introduce services capable of provisioning universal and indiscriminatory access to its business customers through out the country wide. The advent of Intelligent Network technology has brought in the concept TELKOM was looking for into the light.

2. INTRODUCTION

As of today, PT TELEKOMUNIKASI INDONESIA (TELKOM) has gone about restructuring itself into 7 (seven) Regional Divisions and 1 (one) Long Distance Division, along with a number of other supporting Divisions. Aiming to be more responsive and flexible to market needs, restructurisation go about deregulating and further empowering TELKOM's business competence as a national telecommunication provider. Anticipated competition in the market becomes the prominent driver of this shift.

PT TELEKOMUNIKASI INDONESIA, serving as the domestic telecommunication operator in Indonesia, faces two of the most critical challenges at present. One of the company's strategic goal is to provide basic and universal telephone access to the entire population. As a matter of fact, population of the country is not equitably dispersed throughout the nation and moreover the density tends to be concentrated in only some of the big cities in the country. On the other hand, teledensity improvement yields to be cost - intensive.

The second challenge, with equal importance to the first, is to meet the potential demand emerging in the market. Accelerated growth of economy as indicated by the growing business demand in a number of urban communities stimulates network operator to catch up with the services desired by the customer. The additional value the customer would like to have is the ubiquitous nature of the service. From customer viewpoint, service is transparent no matter where, who or what the customer is.

There isn't really a direct relationship in between the first and second challenge. However, meeting the first challenge is the matter of mobilising an enormous investment as to put in place the telecommunication infrastructure needed. Where would the fund come from ? It is likely that meeting potential market demand, as indicated by the second challenge, will bring in substantial revenue needed to fulfil commitment as stated in the first challenge.

Taking into picture these critical challenges, a platform to offer the required services need be available in the network. Open control architecture would be one of the answers on what kind of technology platform need be selected to launching these services. Why open control architecture? Immediate and crucial nature of business demands would be hardly met by means of network rearrangement. Timely service deployment implies such open, centralised and functionally modular structure of technology platform aiming to provision various services on the particular platform. To this extent, **Intelligent Network** fits into light the concept of service provisioning as TELKOM desires.

This paper will go into examining the architecture as well as portfolio of the nation wide Intelligent Network services supported by national Intelligent Network platform. The architecture is mostly based on ITU-T CS1 recommendations and so forthstands as a flexible and developmental foundation to provide a multi-lateral and multi-supplier connectivity as well as an impressive range of services. The article will also examine possible network infrastructures and configurations that might exist in different TELKOM's Regional Divisions or Long Distance Division, ranging from networks providing basic telephone service capabilities, being the primary case in this country, to more sophisticated platform offering advanced range of services as those of the Intelligent Network based. Considerations involved in providing network capability to offer advanced services are examined as well.

3. ARCHITECTURAL VIEW OF IN PLATFORM

This section gives an overview of the Intelligent Network Concept. The various IN building blocks, interface and protocol are also described.

3.1 IN CONCEPT

For several years, many operators have been seeking a technology for the rapid introduction of new services which allows mass customisation of new services and does not require rearrangement of the existing networks or causes serious service interruption to customers. The technology must be ultimately modular and be capable for offering an impressive range of new services in timely manner with an effective development cost.

The idea has come into the light when the Intelligent Network building blocks was introduced. The IN capability, which offers centralised administration and customer database, has enabled telecommunication companies to roll out advanced and revenue generating network based service virtually anywhere and anytime the customers request.

3.2 IN ARCHITECTURE

Service Switching Point (SSP) capabilities exist in switching systems, hardware and software, to provide IN call processing. SSP can detect the conditions requiring IN service treatment and will initiate a dialogue with an SCP.

Service Control Point (SCP) communicates with SSP using an SS7 protocol. It contains a centralised database information and the Service Logic Program which is used to provide IN services.

Service Management Point (SMP)/ Service Creation Environment (SCE) is an interactive service creation, provisioning and administration system that allows the operator to create, customisation, and provision new services.

Intelligent Peripheral (IP) is a node that contains functions and resources required to set up interactive dialogue with an end user. Some of the resources and functions provided by an IP include voice announcements, digit collection, voice recognition, etc.

Figure 1 illustrates an IN architecture and the role of SS7 network which facilitates interactions between every IN building block.

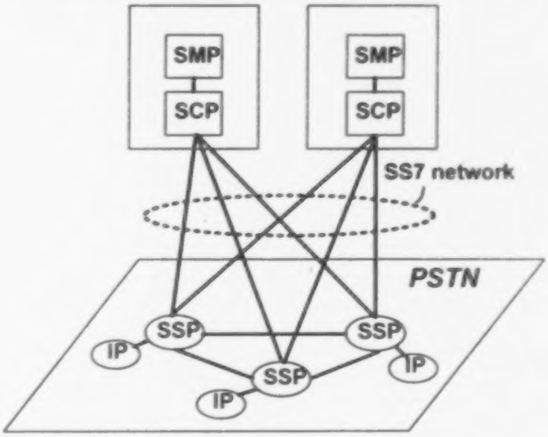

Figure 1. Intelligent Network Conceptual Architecture

4. NATION-WIDE INTELLIGENT NETWORK ARCHITECTURE

Openness in global trade and markets has led the proliferation of national and international corporation in Jakarta and other major cities in Indonesia. This circumstance subtly enlarge the need of a nation-wide platform for high-quality, uniform telecommunication facilities. The platform must meet the challenge to make the services ubiquitous around the country and functionally uniform at national level.

The Intelligent Network building block is suitable for offering the demand of high quality services required by corporate companies and their branch offices in the range across all locations. This architecture preserves capability for supporting the whole range of possible network configurations for participating in the nation-wide Intelligent Network platform. The participating network may vary from a simple Public Switched telephone Network (PSTN), offering basic telephone service, to a more sophisticated telecommunication networks with advanced signalling and Intelligent Network capabilities.

The participating networks belong to Regional Divisions and Long Distance Division that administers long distance nodes

The network configuration will be categorised with respect to the presence of IN functionality, namely:

- Full IN: the networks contain full IN infrastructures as described in section 2.2 (IN Architecture is referred to as Full IN networks.
- Partial IN: this network obviously does not comprise SCP functionality, however it contain either or both the following capabilities:
  - SSP functionality: this SSP functionality allows this network to identify IN call invoked by the customers, but it then relays the IN query to the SCP belongs to another network for further IN call treatment.
  - Switch-based service logic: a network can be classified to this category if it provides a basic number translation using service logic which resides in the switch or in a adjunct processor. It does not offer advanced routing functionality as it is commonly provided by full IN network category. When the demand of IN services tend to increase, this network type can be migrated to full IN network.
- Non-IN: This network category basically does not any capability to offer advanced services, instead of POTS services. This type of network can still reap the advantages of IN services by contracting with another regional office that does have full IN capability.

4.1. KEY ARCHITECTURAL CONCEPT

There are two key architectural concepts that allow nation-wide IN platform available:

- Database-to-Database Communication

This concept permits two different SCPs database belong to different Regional Divisions or Long Distance Division to communicate directly to deliver nation-wide IN services in concert. This idea, also known as internetworking, is principally database sharing amongst SCPs. However, as there is no internationally accepted standard addressing this applications and the development of database-to-database specification will require a substantial amount of time, TELKOM perceives it as a long run solution for its nation-wide IN services.

- Regional IN Nodes

The corporations asking for IN services might be in the location where the Regional Divisions have no capability to offer advanced service immediately. Such Regional Offices can access to "Regional IN" in another region to provide the desires of those business customers.

There are two alternatives for implementing the regional IN. The first alternative, referred to as sole ownership, allows the regional IN to be owned and administered by one Regional Divisions or Long Distance Division, which then arranges to sell or lease IN services to other Regional Divisions. The second alternative, referred to as joint ownership, allows group of Regional Divisions or Divisions to jointly purchase and deploy an IN in a location mutually agreeable to all owners. Both alternatives benefit the participating Regional Offices since IN resources are share resulting in lower capital costs. However, since the database is a shared resource, its administration needs to be carefully controlled.

5. EXPANSION OF THE INTELLIGENT NETWORK TO SUPPORT NATION-WIDE SERVICES

5.1. ARCHITECTURAL VIEW OF INDONESIA'S INTELLIGENT NETWORK

Initial deployment of Indonesia's IN services employs a typical architecture having three SSPs (Service Switching Point) with each connected to an Intelligent Peripheral. SSPs by themselves are mesh-interconnected and each is linked to either one of the two SCP (Service Creation Point) nodes by a CCS7 Network. Service logic incorporated in the SCPs are managed and maintained by the SMP (Service Management Point) within each SCP. Once a new service is ready for installation after being successfully tested in an off-line environment, IN's Service Creation Environment (SCE) will pass over the required logic for the particular service into the SMS, and correspondingly SMS feeds them to the SSP so that the service becomes publicly available in the network.

In its initial deployment, Indonesia's IN platform will begin offering five services to mention : calling card, advanced freephones, universal access number, televoting and virtual private network. Potential market demands for these five services are considered to be the highest at present, and therefore leads to a promising return of investment. Further market assessment is still underway to identify a range of other services to be deployed subsequent to initial offering of the five services mentioned.

As Indonesia is well on the way to implement IN platform, one of the enormous impact affecting the network is openness of service control that was originally performed at the switch level. Proprietary service control in the switch is no longer necessary, since IN will take over the control architecture functionality needed to deploy and activate services. Service deployment and activation are getting much faster and manageable, taking into picture that an open control architecture to name Intelligent Network is in place to handle call - control for the desired services.

However, openness in control architecture is a crucial point that can not be precluded in the progression to IN multivendor and multioperator environment. An open interface from SSP to SCP is severely important. TELKOM is aiming towards that direction by adopting ITU-T CS1 in its IN interface requirement. Accordingly IN related products and equipments should be compliant to these standards as to sustaining the goal of having a multivendor IN environment.

5.2. SUPPORT OF MULTIPLE NETWORK CONFIGURATIONS

Figure 2 illustrates some possible network configurations that can exist in different Regional Offices or Divisions. It describes the flexibility of the national IN architecture, in terms of its ability to interconnect these diverse networks to provide global, multilateral IN services. In any given network, the SSP, the STP and long distance exchange functionality can each be on different physical nodes (i.e. stand alone), or any combination of those functionalities (i.e., any two or all three) can be integrated in one equipment. The figure depicts a mixture of stand-alone and integrated IN functionalities, to provide an idea of the flexibility available.

Division A is shown with a full (SCP-based) IN, an a long distance switch with integrated STP functionality. This network is capable for providing nation-wide IN services using the service logic and subscriber data in its SCP.

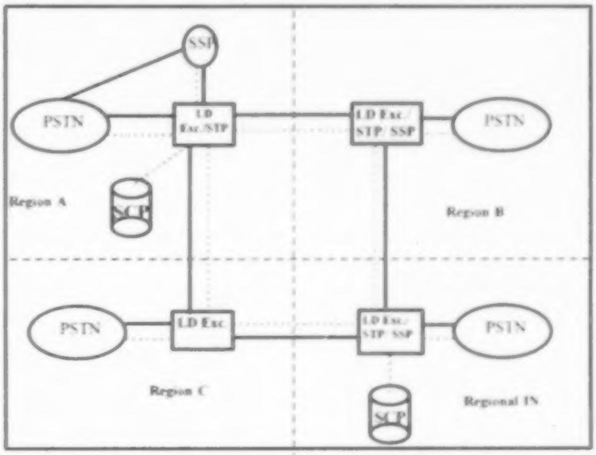

Figure 2. Support of Multiple Network Configurations

Division B does not have a full (SCP-based) IN. SSP and STP functionalities are both integrated into the long distance exchange. Since only the SSP function is available, referred as to partial IN, this network therefore relies on a regional IN.

Division C does not have any IN capability in its network, and therefore cannot provide any IN services. This configuration would also need to rely on the regional IN to offer IN services to its subscribers.

Though the figure depicts the regional IN as a separate network, any network with a full IN can serve as a regional IN. For instance, Region A can serve as a regional IN.

6. NATION-WIDE INTELLIGENT NETWORK SERVICES

Subsequent to the identification of potential in - country market demands, TELKOM is well underway to initiate the following services precedent of others to come in the future. The initial services to be offered are :

VCC (Virtual Card Calling)

Virtual Card Calling allows service user to place a call arbitrarily from any end terminal, and in accordance have his usage - charge billed to his personal account.

Freephone

Freephone Service enables the calling party (service user) to reverse charge of the call into the called party (service subscriber). In other word call - charge is not billable to the calling party but conversely call - charge is billed to the called party.

Premium Rate Service

Premium Rate Service permits the calling party (service user) to access 24 hour a day based information provided by a particular service-provider (service subscriber). Calling party is then billable of the information - access charge (in addition to the regular charge for the line - usage).

UAN (Universal Access Number)

Universal Access Number service assign a single number mechanism for a service subscriber having multi locations, and so become nationally reachable by any calling party under that one and only number.

UPT (Universal Personal Telecommunication)

UPT render a personal number to any service subscriber, therefore allowing the particular service subscriber be reached under his/her personal number.

The mechanism would also enable a service subscriber to call arbitrarily from any terminal and accordingly have the call charged under his/her personal UPT number.

VPN (Virtual Private Network)

VPN service connects a service subscriber, usually characterised as a company having multiple branch - offices, to and from its associated branch - office as if the service subscriber runs a private network fully supported by inherent capability of a real private network. Respectively service subscriber will receive a single and overall invoice due to its VPN service - usage.

7. CONCLUSION

TELKOM concentrates its strategy to increase subscriber density level, while in the same time the company requires to fulfil the desires of its business customers.

The proliferation of business activities throughout the country-wide stimulates the provision of fast service activation in an open architecture environment. Intelligent Network is the solution to the problem.

Multilateral and multivendor environment need be implemented to support multiple connection at various layers of the network.

Two possible configurations are worth considering : Regional IN Node and Database-to-Database Communications. The latter option seems to be more of a long term solution since the former is not fully recognised by the international standard . The first option is a more suitable at present. Regional IN node comes along with two alternatives : sole ownership and joint purchase. In both alternatives, database ownership should be carefully assessed.

Potentially profitable services to meet market demand in IN's initial offering are identified as Freephone service, Private Virtual Network service, Premium Rate service, Universal Access Number service, Universal Personal Telecommunication service and lastly Virtual Card Calling Card service.

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A Classification of UPT Service Data in Intelligent Network

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Abstract

The service data of Universal Personal Telecommunications are divided into those of home and local Service Data Functions, respectively. The purpose of this paper is to classify UPT service data to satisfy UPT service requirements. We introduce requirements, configuration, and architectures of Service Control Function-Service Data Function. We compare the configurations with 6 data types in Intelligent Network Recommendations. This paper classifies service data as hierarchical relationship, domain and management of UPT service data.

1. Introduction

The solution for telecommunications services moves to Intelligent network services from switching services. Mobile service in telecommunications has been defined as Future Public Land Mobile Telecommunication Systems(FPLMTS) in ITU-R and Universal Personal Telecommunications(UPT) within the scope of Intelligent networks in ITU-T.

The volume of UPT service data is larger than that of traditional telecommunications service data. UPT service data(or profile) have additional data related terminal mobility and personal mobility.

The increased data make easily customized services in telecommunications, but cause a side effect of decreasing network performance. It will rapidly lead to a bottleneck. This necessitates a data classification and schema design[8][5-6][10-12].

The service data include service logic programs, subscriber specific data and management information. Service Data Function(SDF) contains and manages the data that are used by Service Control Function(SCF).

The purpose of this work is to classify UPT service data to satisfy its requirements. In this paper, we will introduce requirements of the UPT service data, and configurations and architecture of SCF-SDF in chapter 2, and 6 data types in ITU-T Recommendation in chapter 3. We will classify UPT service data of Intelligent network as hierarchical relationship, management, and operational domain in chapter 4.

2. Intelligent Network for UPT

2.1. Growing up level of Service logic network

The trend in the switching networks is to further reduce the number of levels to one or two according to introducing and level growing of SCF/SDF as shown in Figure 1 [1].

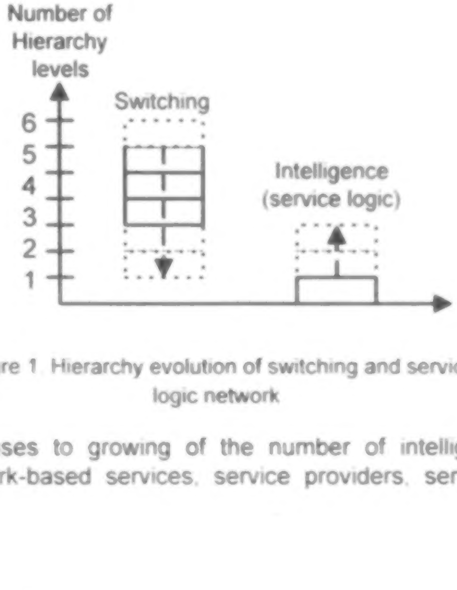


Figure 1. Hierarchy evolution of switching and service logic network

It causes to growing of the number of intelligent network-based services, service providers, service subscribers, and the amount of UPT subscriber's profile.

This growth results in an increase of the signaling traffics between the SCF and SDF. So, service data should classify for reducing that traffics.

2.2. Intelligent Network functions for UPT

Intelligent network must be able to support the following functions when it provides UPT[5].

- Location tracking and registration.
- Call delivery.
- Authentication and verification.
- Registration/deregistration.
- Resource and service profile management.
- Billing.

2.3. Requirements of UPT Service Data

Requirements of UPT Service Data in Intelligent network are as follows[5].

- User's profile data location transparency
- User's profile data access transparency
- User's profile data replication transparency[13]
- Separation SCF-SDF
- Multiple SDF
- Security data
- data consistency

2.4. Requirements of Intelligent Network Database

The key requirements for Intelligent network database architecture are data distribution[14], data replication, fault tolerance, and real-time transactions[10-12][17].

2.5. Architecture of SCF-SDF

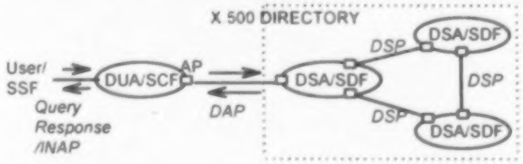
Intelligent network can use another area technology, for example X.500 or TINA, for construction of SCF-SDF architecture.

2.5.1. Single Combined SCF-SDF

Single Combined SCF-SDF has no standard interface. Interface between SCF and SDF is dependent vendor. This architecture has a problem to interface with multiple SCF or multiple SDF.

2.5.2. SCF-SDF Interface with X.500 Directory

The architecture with X.500 Directory has been standard ITU-T Intelligent Network Capabilities 1 and 2. This interface shows in Figure 2.



AP Access Point
DUA : Directory User Agent
DAP : Directory Access Protocol
INAP : Intelligent Network Application Protocol
DSA : Directory System Agent
SSF : Service Switching Function
DSP : Directory system Protocol

Figure 2. Interface with X.500 Directory

2.5.3. Realization of SDF with TINA

Data access by the use of Telecommunications Information Networking Architecture(TINA) computational objects will allow data distribution transparency and further data federation[2][3].

The TINA objects in Figure 3 divide into four groups: Access Session Objects(ASO), Service Session Objects(SSO), Subscription Management Objects(SMO), and Accounting Management Objects(AMO). These objects will be located on a TINA Distributed Processing Environment(DPE). They have to access through DPE to all data-related operations during service execution and management.

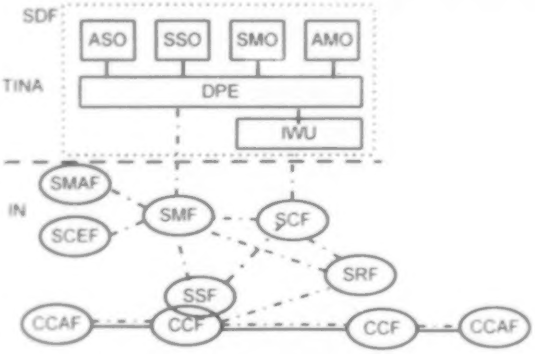


Figure 3. SDF with TINA

2.6. Configuration of SCF-SDF

We define configuration of SCF-SDF as Single SCF and Single SDF(SCSD), Single SCF and Multiple SDF(SCMD), Multiple SCF and Single SDF(MCSD), and Multiple SCF and Multiple SDF (MCMD). We compare with it in Table 1.

Table 1. Comparison of SCF-SDF Configuration

	SCSD	SCMD	MCSD	MCMD
Number of service	small(1<n <5)	middle(1 <n<10)	middle(1 <n<10)	large(n >25)
Number of subscribers	small	small	small	large
Subscriber's profile	simple	-	-	complex
Number of Provider	single	single	single	Multiple -vender
standard	no standard	IN CS-1/2	-	IN CS-3

2.6.1. Single SCF and Single SDF: SCSD

SCSD is first or introduction phase in Intelligent network. SCSD has no standard interface between SCF and SDF. It is used in small country, small number of services and subscribers, and providing by single vender. This method has characterization of tightly coupled between SCF and SDF with a vender specific interface[4].

2.6.2. Single SCF and Multiple SDF: SCMD

There had been no problem to handled service data when it was small. Intelligent network becomes a large volume of service data according to introducing UPT. The service data are divided into two parts for its control efficiently. That is a home SDF and local SDF. So, Besides the locally available service data objects, additional data is used to locate service data objects in other SDFs in the network.

SCMD is developed to introduction UPT service. UPT require multiple SDF with SDFhome and SDFlocal. This architecture was adapted for the revised Recommendation Intelligent Network Capabilities Set 1 and 2.

2.6.3. Multiple SCF and Single SDF: MCSD

MCSD has two more identical SCFs, physically separated for some purposes[4][16]. For traffic handling, mated pairs of SCFs could offer different solutions[1]:

- Redundancy: One SCF is the executive and handles all traffic, while the other remains passive and on standby. If the executive SCF fails, the standby takes over the traffic immediately.
- Loadsharing: Both SCFs are executive, either for different types of traffic(different services) or for the same services in different geographical areas
- Redundancy and loadsharing: they are both also on standby for each other

2.6.4. Multiple SCF and Multiple SDF: MCMD

MCMD can consist SCF dependent SDF and SCF independent SDF. MCMD needs full standardization between SCF-SDF. It requires inter-working operations and multiple vendor's coordination.

3. Standardization of data types

Standardization of data types is defined in SCF and SDF functional models of distributed functional plane in ITU-T[18].

3.1. Service Control Function Model

3.1.1. SCF data access manager

The SCF data access manager provides the functionality needed to provide for the storage, management, and access of shared and persistent information in the SCF. The SCF data access manager also provides the functionality needed to access remote information in SDF.

The SCF data access manager manages two structures that contain SCF data. These are the service data object directory and the intelligent network network-wide resource data.

3.1.2. Service data object directory

The service data object directory provides a means to address the appropriate SCF for access to a specific data object. The SCF data access manager uses service data objects in SDFs to locate service data objects in the network in a manner transparent with a global and uniform view.

3.1.3. IN network-wide resource data

It provides a means to address the appropriate functional entity(e.g. SRF) for access to specific resources with the appropriate capabilities in order to have a global and uniform view of resources in the network.

3.2. Service data function(SDF) model

The purpose of SDF model is to provide a framework for service data functionality subjects with respect to the SDF. Figure 4 shows in SDF model.

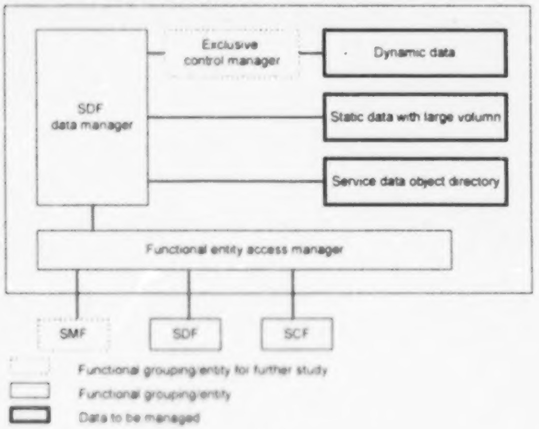

Exclusive control manager
Dynamic data
SDF data manager
Static data with large volumn
Service data object directory
Functional entity access manager
SMF
SDF
SCF
Functional grouping/entity for further study
Functional grouping/entity
Data to be managed

Figure 4. SDF data model

3.2.1. SDF data manager

The SDF data manager provides the functionality needed for storing, managing, and accessing information in the SDF. If, for example, the data are physically structured as a database, the SDF data manager may also handle database accessing language such as an SQL.

3.2.2. Functional entity access manager

The functional entity access manager provides the functionality needed by the SDF data manager to exchange information with other functional entities, i.e. SCF, SDF, SMF, via messages.

3.2.3. Exclusive control manager

The exclusive control manager provides the functionality needed to provide exclusive control, for example lock-unlock control, to ensure data integrity.

3.3. Data types handled by SDF

These types of data are further subdivided as 6 data types in ITU-T Intelligent Network Recommendations. It shows relationship of 6 data types in Figure 5.

3.3.1. Type 1 data

These are dynamic data that are local to an SLPI, e.g. call instance data parameters like the dialed number.

3.3.2. Type 2 data

These are static data that are feature-specific and are shared by SLPIs, e.g. subscription data parameters like day of week or time of day screening.

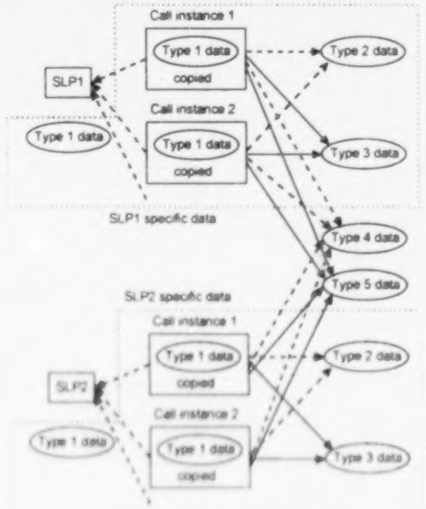

Call instance 1
Type 1 data
copied
Type 2 data
SLP1
Call instance 2
Type 1 data
Type 1 data
copied
Type 3 data
SLP1 specific data
Type 4 data
Type 5 data
SLP2 specific data
Call instance 1
Type 1 data
copied
Type 2 data
SLP2
Call instance 2
Type 1 data
Type 1 data
copied
Type 3 data

Figure 5. Relationship of 6 Data Types

3.3.3. Type 3 data

These are dynamic data that are feature-specific and are shared by SLPIs, e.g. sum of charging or a counter for a call number limiting service. Here, it is assumed that an SLP includes type 1 data. Other than above data, there can exist the following data types which may commonly be accessed among SLPIs for multiple service features.

3.3.4. Type 4 data

These are static data that belong to multiple service features and are shared by SLPIs, e.g., a subscriber's phone number list to connect.

3.3.5. Type 5 data

These are dynamic data that belong to multiple service features and are shared by SLPIs, e.g. subscriber's location data used by a service such as UPT.

Besides the locally available service data objects, additional data is used to locate service data objects in other SDFs in the network. The additional data are used in a manner which is transparent to the SLEM(and its SLPI) in the SCF requesting the locally unavailable data.

3.3.6. Type 6 data-Service data object directory

Upon a data object retrieval request by the SCF, the SDF data manager will try to locate the data object locally. When the requested data object is not available, it will try to retrieve a reference to another SDF from the Service Data Object Directory (SDOD). If a reference is available, the SDF will either refer this back to the requesting SCF, or try to retrieve the requested data directly from the referenced SDF. If a reference is not available, the SDF data manager will return a failure to the requesting SCF.

3.4. Comparison of data types

We compare the 6 data types with configuration, category, and domain classification as shown in Table 2. The service data are classified as static and dynamic. The static data are read-only as far as Service Logic Processing Programs(SLP) in SCF are concerned. The dynamic data can be changed by SLP.

Table 2. Comparison of Data Types

	Configuration	Category	Domain
type 1	SCSD MCSD	dynamic	local
type 2		static	feature-specific
type 3		dynamic	
type 4		static	multiple service feature
type 5		dynamic	
type 6	SCMD		

We could not compare configuration MCMD with ITU-T Recommendation`s data types. This result of comparison needs new data type and classification of data in chapter 4.

4. Classification of UPT service data

4.1. objective of classification data

Depending on the specific needs of the service, it may be advantageous to distribute and replicate(referral and replication in X.500) customer records at multiple places in the signaling network for fast, easy access and reuse of it[5-8].

That is realized with data classification, extract of common data between services/systems and standardization of common data and their interface.

4.2. Management data classification

Management related data are classified as accounting related data, configuration related data, security related data, performance related data, and fault related data[9].

4.3. Domain operational data classification

We classify operational data in respect to domain as service data, service feature data, system data, intelligent network capability set data, and network data.

4.4. Hierarchical relationship of IN data

Service A has a service data A'. Service B has a service data B'. Service C has a service data C'. There are common parts among services A, B, and C as shown in Figure 6. .

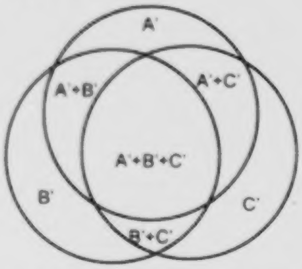

A'
A'+B'
A'+C'
A'+B'+C'
B'
C'
B'+C'

Figure 6. Degree of common service data

We show a hierarchical relationship of service data in Figure 7.

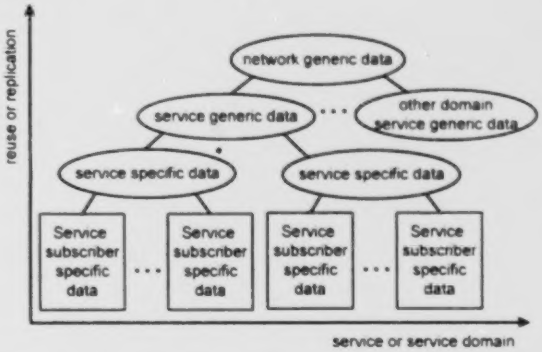

reuse or replication
network generic data
service generic data
other domain service generic data
service specific data
service specific data
Service subscriber specific data
Service subscriber specific data
Service subscriber specific data
Service subscriber specific data
service or service domain

Figure 7. Hierarchical Relationship of Service Data

The capability of intelligent network service data can be recognized as follows[9][15]:

- Network generic data: capabilities are generic for all vender`s network.
- Service generic data: capabilities are generic for all service, e.g., $A' \cap B' \cap C'$ in Figure 6;
- Service specific data: capabilities are service specific but common for service subscribers, e.g., $A' \cap \neg (B' \cup C')$, $B' \cap \neg (A' \cup C')$, $C' \cap \neg$ (B'

∪ A') in Figure 6;

- Service subscriber specific data: capabilities are service subscriber specific as well as service specific. This is example of 6 data types.

5. conclusion

We can find that an increasing number of SDFs is supporting the SCF. The intelligent network-based logic of telecommunications networks will interwork with outside database owned by large companies, such as banks and finance companies.

In this paper, we introduced requirements for the UPT service data, configurations and architectures of SCF-SDF, and 6 data types for services in ITU-T Intelligent Network Recommendations. We defined configuration as SCSD, SCMD, MCSD, MCMD. We compared configuration with 7 data types. We also classified service data as hierarchical relationship, domain and management of UPT service data.

We conclude that network generic data for MCMD are used for UPT service database owned by multiple telecommunication company.

We believe that classification of service data in Intelligent network is flexible enough to answer the current and future intelligent network requirements, as well as many other telecommunications network requirements. Our work and research need more study before we have a full Service Data Control Mechanism for UPT.

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Telecommunications in the People's Republic of China - the present status and future development

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1. Abstract

This papers aims to discuss the telecommunications industry in the People's Republic of China with a view to demonstrating its distinct characteristics and the potential for future developments. It begins with a brief description of the historical advancement of telecommunications. Then a few selected service sectors that have experienced interesting developments are examined more closely. These are radio paging, cellular communications, internet, information superhighway, convergence. The complexities surrounding the future development such as the law and regulatory environment, foreign participation, and some technical and financial implications are also mentioned. A topic of particular interest to the international telecommunications community, namely the perceivable role of foreign enterprises, is addressed.

2. Historical Perspectives

Dating back as far as 3,000 years ago in the Dynasty age of China, very primitive signals such as drumming sounds and fire glares were utilized to transmit messages during war times. In the subsequent 2,000 years there were massive constructions of roads which furnished the means for human messengers riding on animals such as horses and camels to travel around. There were intermediary ground stations to function as relay points for the travel of messages from the origin to destination. The evolution of the communications mode occurred throughout the history in concert with the evolution of civilization. A landmark turning point of particular significance was the influx of the post and telecommunications concept from the West into China after the Opium War around 1840's.

In the modern era, China established the Ministry of Post & Telecommunications (MPT) in 1949 shortly after the Communist Party gained the sovereignty power. This marks the dawn of the modern telecommunications and gives rise to a state monopoly for the provision of telecommunications services in the nation. This monopoly has been continuing until July 1994 when the second public network operator, China United Telecommunications Corporation (also known as Unicom and LianTong) was founded after massive efforts on the part of the Ministry of Electronics Industry (MEI). The establishment of Unicom has transformed the natural monopoly into a duopoly competition environment.

Under the control of MPT, the public telecommunications network was developed virtually from scratch in around late 1940's to a telephony penetration rate of around 0.3% by 1980. The reported cumulative network investment up to the year 1980 was around 6 Billion Yuans. In the subsequent 10 years (1981-90), the total investment figure reached 26 Billion Yuans; during 1991-1995 the investment figure escalated to 134 Billion Yuans. The penetration rate has been improved to 1.1% by 1990, and to 4.5% by 1995 respectively. Viewing from the operations perspective, the network revenue for the year of 1994 reached 56.1 Billion Yuans which represented a 56.2%

increase from the previous year. China's telecommunications industry has been experiencing an average growth rate of 40-50% for years.

MPT has set a goal to achieve a nationwide penetration rate of 10% by year 2000, in the coastal cities and provincial capital cities it will be as high as 30-40%. This means adding 10 million lines every year. To reach this target, the required investment has been very conservatively estimated to be around 100 Billion US Dollars. Up to the present, the telecommunications infrastructure equipment has largely been procured through import because China has not possessed the sophisticated manufacturing facilities. Thus China is regarded as an important strategic export market for multinational vendors. The telecommunications operators have likewise viewed China as a high-priority market target. Although the Chinese laws strictly prohibit direct foreign participation in the telecommunications operation, many foreign operators have participated in network construction, financing, and technical assistance. Most of the Unicom GSM networks launched in 1996 have been implemented through such arrangements.

The implementation of networks in the future will require gigantic amount of foreign currencies. From the perspective of Chinese authorities, the need for a balance between conserving the state control over the telecommunications and utilizing the foreign capital to resolve shortage of foreign currencies. From the perspective of the foreign operators, the opportunity for long-term participation in the service operation is most attractive. This is not yet permitted. The roles of foreign operators in China's telecommunications development will be an issue of foremost interest. What opportunities are available for Western enterprises? How do they harness these opportunities effectively? How will the new the telecommunications laws and regulatory policies take into consideration such compelling issues?

3. Selective segments of industry

This section will attempt to discuss five service sectors. The first two cases are radio paging and cellular mobile communications that have experienced an enormous growth in the last 5 years. The third and fourth cases are the information superhighway and internet that are currently in the forefront of worldwide wave of activities. The final case will be the hybrid fibre/coaxial network that demonstrates the convergence of computing and telecommunications industry and that will involve multi-ministries for its implementation. These cases are selected with the aim of illustrating the future potential as well as the complexities surrounding the telecommunications industry of China.

3.1. Radio paging

Since the public radio paging service was started in 1984, the volume of users has been increasing at 70-215% per year. At the beginning, this service segment had continuously encountered a supply shortage and naturally been perceived to be a profitable business which attracted more and more service providers into the market place. By the end of 1995, the government agencies had already issued over 2,000 permits for the paging operation. To date radio paging is the single telecommunications service that has achieved the highest level of open competition. The demand for the service and the price have fallen into the loci of a vicious cycle. This has been one of the impetus for its current widespread of usage.

China has a large mobile population and a very low level of cellular telephony penetration. The cellular mobile communications service has been extraordinarily expensive until recently when Unicom started to offer GSM services in the market. In such circumstances, radio paging has provided an alternative means of achieving mobile communications capability. Thus this segment has been experiencing a tremendous rate of growth.

There are two categories of radio paging operators together having a total capacity of over 1,000 million users. In April 1996, there have been over 20 million users in the MPT paging systems and over 10 million users in the non-MPT systems. At the present, the radio paging networks largely use manual connection method which therefore requires a significant number of operators to make paging connections. At traffic peaks, for instance when the traffic exceeds 0.5 Erlang, the successful connection rate will be low and connection errors will occur. The future radio paging services will need to compete on the basis of the price of service as well as the efficiency of operation and service quality. Thus, the future development will employ automatic paging to eliminate operator errors, human communications errors, and at the same time also improve successful connection rates, spectrum efficiency. Moreover, there will be more innovative service features. Some such instances include value-added services like the mail box service; charge to calling party feature; inter-provincial roaming feature to develop the radio paging as a nation wide utility. This can be achieved by integrating the existing radio paging networks into an interconnected large-scale network through a merger and acquisition process.

The open competition in the radio paging results in an uneven development of radio paging services in different geographic regions of China. There have been massive investment and network construction in the more developed coastal cities whereas there is still very little coverage in rural areas where 80% of China's population are living. This is similar to the overall uneven economic development in China. It has been estimated that there are 200 million family units and 20 million township enterprises in the rural regions. The infrastructure particularly the access network that is essential for deployment of fixed network is still lacking. In this circumstance, radio paging can serve as the interim solution for bringing telecommunications into the rural areas. Achieving the goal of one user in each enterprise will triple the volume of radio paging users. Thus, the deployment of radio paging in the rural area will have significant market potential as well as technical challenges.

3.2. Cellular mobile communications

The cellular mobile communications was first developed in major commercial cities like Shanghai, Beijing and GuangZhou starting with the analog TACS system around 1986-87. To date, TACS network has been expanded to a size of 3,900 base stations reaching a network capacity of 6.65 million subscribers. At the present, there are already over 4 million active users.

MPT developed the digital cellular communications in 1994 also starting with the major commercial cities. The digital network has adapted the GSM system. Because 15 MHz of the GSM spectrum has already been allocated for TACS networks, only 10 MHz is available for the GSM networks. The second network operator, Unicom, has chosen to begin its operations with the GSM network and launched GSM services in 1995. Two competing GSM networks share a frequency spectrum of 10 MHz (4 MHz for MPT and 6 MHz for Unicom). Unicom has been granted a wider spectrum than MPT possibly because MPT already has other portions of the 900 MHz for the analog mobile networks whereas Unicom does not operate analog networks.

At the end of June 1996, the Unicom GSM network had 50 thousand subscribers whereas the MPT GSM network already reached a subscriber volume in the vicinity of 1 million. Mobile communication is the first service item introduced into the duopoly competition environment. Despite this, MPT still maintains its dominant market position

The cellular mobile communications in China has evolved from the analog TACS system at the beginning to the digital GSM system at present. There are very strong speculations that the future mobile networks will be based on CDMA technology. In employing this technology, there are two important issues namely to allocate the frequency spectrum and to devise a methodology to utilize the CDMA technology most effectively to cope with practical situations of China. Specifically it is essential to consider how the CDMA systems will be deployed in relation to the TACS and GSM systems. There are also some speculations that DCS1800 will be a technological choice of the future. The existing network capacity is much smaller than the demands. The technical innovations for enhancing the network capacity using the given bandwidths will play a major role in the success of future mobile communications operators. Overall speaking the mobile communications will be a technology-driven competition.

China's implementation of GSM is in line with the current global trend. Hence GSM will undoubtedly be a major development focus in the next 5 years. It is interesting to note that the analog network is introduced in China about 10 years after its introduction in the developed countries whereas the introduction of the digital mobile communications takes place in about the same time frame. Hence the TACS system is still regarded as a sophisticated mobile communications network in China at the present time. However, the TACS network capacity has already become a bottleneck for high-traffic urban regions. Therefore it has been proposed to deploy the CDMA technology in a dual mode TACS/CDMA system. In this way, the high capacity feature of CDMA is utilized to resolve the capacity bottleneck being encountered in the analog system for the high-traffic urban areas. At the same time, TACS can still be used in the suburban and more remote areas where the capacity is not a compelling problem. This scheme would yield an economical solution to improve the network coverage and capacity simultaneously.

3.3. *Information superhighway*

China's information highway includes two parts. The public network of MPT consists of 22 main optical fibre systems and 19 large satellite Earth stations. Another 17 fibre trunks will be added by the year 2000. The private network consists of fibre optics, digital microwave and VSAT systems run by other ministries such as the Ministry of Railway and state corporations. The public and the private networks are not well coordinated, thus making the communications between these two networks very difficult. Here I propose to examine two questions. Who will control the future of information superhighway? What will be the pattern of future development?

Let us take the data communications as an example for our analysis. In this current status of the information highway, MPT possesses the capability to offer public data communications services for market activities and business transactions through three major national networks.

1. CHINAPAC is a packet switching data communications network covering over 700 cities. Currently it has been connected with 44 packet switching networks in 23 countries and regions.
2. CHINADDN is an optical fibre based public digital data network covering over 300 major cities.
3. CHINANET is China's interior part in the world of Internet with a transmission rate of 256 kbps which already offered services by the end of 1995 to about 100,000 subscribers.

MPT has enjoyed the privilege of natural monopoly for over four decades, and no doubt has gained a dominant position in the information highway industry in all service sectors. It possesses a huge operational base and infrastructure network for competing in the new duopoly environment. The biggest challenge to the incumbent MPT is the strategic alliance of other ministries led by the Ministry of Electronics Industry. These founding ministries own private networks which can be linked to form a public network. This was in fact one of the compelling reasons for the formation of Unicom to provide public telecommunications services. For instance, Ministry of Railway owns 35,000 km of open-air lines, 30,000 km of coaxial cable and 3,000 km of optical fibre cables. It has also set up numerous microwave links and 400,000 lines of switching capacity. The Ministry of Electric Power owns 27,000 km of digital microwave links. Furthermore, MEI has a strong R&D and manufacturing base covering electronics, computer software and hardware, and communications technologies. Hence MEI possess a distinct advantage of technical capability. In particular, it is in an ideal position to harness the convergence of computing and information technologies.

In addition to Unicom, JiTong Corporation which was founded in 1992 by MEI to provide data services through VSAT network is another significant player. JiTong started out its mission by launching the so-called "Three Golden Projects". The Golden Bridge Project constructs a national public information backbone network which will link major dedicated networks of government organizations, and connect 30 information centres and 12,000 state-run enterprises in over 400 cities. By 1995, 24 satellite earth stations had been set up for operation across 20 provinces and also connected to some Internet networks. The Golden Customs Project connects all of China's customs offices into a single computer network. The Golden Card Project aims at connecting China's banking system. Subsequent to 1995, new projects have been added to the agenda such as Golden taxation, Golden enterprise, Golden Agriculture etc.

Now who will control the information superhighway? It is no longer the exclusive control by MPT. In this decade, many contenders have entered into the information industry. At the highest level, it can be said that the information superhighway will be jointly controlled by MPT and MEI albeit their currently unparalleled market positions. Next, the state enterprises such as the founding shareholders of Unicom and major users of telecommunications services such as People's Bank of China etc. would be significant players. They participate in financing of network construction. MPT has founded China Telecom to be responsible for the operation mandate. Although it has obligations for universal services, it will be becoming more entrepreneurial and will be cooperating with corporations for network construction and financing through which more players will emerge into the information industry.

Perhaps to differing extents, all the operators will be focusing their investments in areas having high profitability. Although the telecommunications sector appears to develop towards a free-standing market economy, there are several concurrent factors. First, the local economic status must be able to sustain profitability for the operations. Secondly, advanced services are dependent upon having basic telephony access and computer access rates which are correlated to the regional economic development. This implies a tendency to inject new investments into more economically developed regions. With a poor telephony penetration rate and an extremely low computer access rate, the future advancement of this information highway will necessarily be tailored in line with the economic development.

3.4. Internet

Since Internet made its place in China in 1984, it has experienced very rapid growth. Internet will continue to be a relatively open communications service segment. In January 1996, four agencies have been granted the right to manage international gateways of China Internets, these are MPT, MEI, China National Education Commission and Chinese Academy of Sciences. To date, there are numerous networks in operation. Some of these networks are:

1. Chinese Academy of Science (CASNET)
2. China Education and Research Network (CERNET)
3. JiTong Communications Corporation (GBNET)
4. China Commercial Network run by MPT (CHINANET)
5. Beijing University of Chemical Industry Network (BUCINET)

3.5. *Convergence*

In the realm of convergence of the telecommunications with computing industry, broadband access networks for providing the last mile of the information superhighway is critical. This can be achieved through Hybrid Fibre/Coax (HFC) integrated network which possesses several advantages including its iterative feature, multi-media function, bandwidth capacity and cost performance ratio. It is hoped that this mechanism will eventually attain the ultimate goal of providing integrated information services to every home (the notion of Fibre to the Home).

The deployment of HFC network in China presents many complex challenges. The Ministry of Radio, Film & Television (MRFT) has rights to build CATV networks and provide TV programs. MPT and China Unicom have rights to operate telecommunications networks. Hence multi-ministry cooperation is necessary. Currently, MEI, MRFT, China Unicom are already conducting a trial which is divided into four phases. Phase 1 was a Lab Test which has been completed in July 1996 in the test laboratory of China Communications System Co., Ltd. Phases 2 and 3 are the Field Trial and Commercial Pilot which are planned to be completed in March and December of 1997 respectively. Hence, the final phase of Commercial Launch can be anticipated in 1998. According to this plan, HFC networks will provide not only TV, telephone and data services, but also NVOD and value added services.

4. Present characteristics

4.1. *Industry transformation*

The most remarkable event in the telecommunications industry of China is seen to be the transformation from state monopoly to the current duopoly competition within which MPT and MEI are the anchorage players. They have respectively established China Telecom and China Unicom as commercial enterprises to deliver the telecommunications services. In the past, the MPT combined regulation and operation functions into one body. Now, the separation of operation and regulation appears to be resolved. The progress to date signifies results of tremendous efforts on the part of the Chinese government particularly the MEI. Such activities are in line with the global trends that can be characterized by the almighty expression of competition and privatization!

Similar to many countries, the competition starts with the cellular mobile communications. The competition in long distance and international services will appear in the near future. In fact in 1995, MPT and PLA (People's Liberation Army) have been granted permission to prepare for establishment of a third public mobile operator to deploy CDMA technologies over the 800 MHz spectrum owned by PLA and the PSTN owned by MPT. Therefore, one can argue that the telecommunications sector of China will advance towards a more and more competitive environment.

A close examination into the structure and management of China Unicom will reveal some insights. At the first instance, the corporation has a long list of shareholders all of them are highly influential and financially strong enterprises. This signifies the surge of strategic diversification of enterprises into the telecommunications industry. Secondly, Unicom has created local subsidiaries to cooperate with financing partners and other partners. This has triggered emerging interest of state enterprises and private corporations in the telecommunications industry.

MPT has employed a multi-tier mechanism in the service operation although it usually attempts to centralize the control. The MPT has established the hierarchy of PTA (Provincial Telecommunications Authorities) and municipal telecommunications authorities. The development in the provinces and municipalities will necessarily have to be guided by the local economic environment. This will be even more pronounced in the future competition environment. Hence China's telecommunications will be advancing towards a more decentralized and liberalized market whereby more and more players will be indulging in the competition.

4.2. Value-added versus basic services

Although the nationwide telephony penetration is currently about 5%. There is a huge disparity of telephone penetration rate between urban and rural areas. Out of the total population of 1.2 Billion, only about 20% are living in cities where the penetration rate has exceeded 10%. It has reached as high as 30-40% in major cities such as Beijing. For the majority of population living in the suburban and rural regions, the penetration rate is significantly below 5%. In the remote countryside, habitants have no access to the basic telecommunications.

The competition environment will continue this situation of uneven development because efforts will be concentrating in the more developed regions. In the major cities, the value-added services will rise. In the less developed regions, the need for basic service such as the access network still remains.

4.3. Foreign participation

Let us analyse the foreign participation by first examining some financial figures. By the year 1994, China had invested a total cumulative figure of 170 Billion Yuans (equivalent to about 20 Billion US Dollars at today's exchange rate) into the infrastructure network. The state finance over a 10-year period ended then accounted for 1 Billion US Dollars. About 6 Billion US Dollars of foreign capital had been used. The balance of the finance came from the operation revenues primarily the activation fees.

There is no evidence of any possibility for substantial state finance both at present and in the future. What about the operation revenues from the activation fees? Just during the year of 1994, MPT installed 12 million fixed lines at around a few thousand Yuans per line, and 900,000 mobile phones at over 10 thousand Yuans per line. These activation fees add up to several tens of Billion US Dollars. However, this was possible only in monopoly times. As the competition becomes more intense, the profits from activation fees will diminish quickly.

China Unicom was incorporated with a capital injection of 150 million US Dollars. How could a second operator with this small capitalization compete with the incumbent to provide all basic telecommunications services nationwide covering a population of over 1 Billion that at the present has a telephony penetration rate below 5%?

These developments make it necessary to seek new investment sources including foreign capitals. So far, the current regulations have always prohibited direct foreign participation in the telecommunications operations and management. The role of foreign enterprises in the past have been limited to equipment sales, loans, technical cooperation most notably technical consultancy and personnel training. From above analyses, it is evident that the state finance and foreign loans will only contribute a small portion of the estimated 100 Billion US

Dollars required for the development by the year 2000. If participation in the operation and management is not permitted, it would be difficult for either China Telecom or China Unicom to attract large amount of foreign capital. Thus it seems logical that foreign participation should be enhanced in order to attract sufficient capital to keep the pace of the projected development.

This is recognized by the Chinese authorities. At the end of 1994, MPT issued a Directive to encourage its branches to attract capital from foreign banks and investment consortia. Otherwise, there is simply not a sufficient capital basis to meet the pace of development. This is a very compelling problem. The most economically developed regions hope to sustain their leadership through continuous advancement of the information society. The less developed regions hope to eliminate disadvantages through modern telecommunications facilities.

5. Future Development

5.1. Development target

In 1992, MPT estimated that the telephony penetration rate would reach 5% by the year 2000. To date it has already reached this target. Now MPT plans to achieve the following target by the year 2000:

Subscriber volume

- Fixed network subscribers: 123 million
- Cellular subscribers: 18 million

Network capacity

- Public network switching capacity: 150 million lines
- Long distance switching capacity: 6 million lines
- Fibre optic trunks: 210,000 km

China Unicom has plans to reach the following status.

Subscriber volume

- Fixed network subscribers: 8 million
- Cellular subscribers: 3 million

Network capacity

- Long distance switching capacity: 600,000 lines
- 10 fibre optic trunks totaling 22,000 km
- 2 microwave trunks totaling 2,734 km

5.2. Technological options

It is beyond a doubt that the cellular communications will be heavily based on the GSM, CDMA, DCS1800 systems. The efficiency of the spectrum usage will be of paramount importance. This is considered to be a practical way of resolving the capacity bottleneck of the existing networks as the subscriber volume is bound to be rising quickly within the next 5 years.

The newly emerging wireless access (FWA) technologies will also experience widespread application. FWA is being perceived as a potential for quickly resolving the lack of access network infrastructure that is a critical bottleneck for the advancement of telephony penetration rate in China particularly in remote parts of the suburban regions. There is a major obstacle to overcome. Currently there is no unified standard for this application and the frequency spectrum has not been allocated. Field trials have been conducted.

In the realm of transmission, C-Band VSAT will be heavily used in the dedicated information networks. SDH optical systems will be deployed widely in the public transmission networks. In the switching part, ATM has begun to receive attention.

The hybrid CATV and telephony network is becoming a highly interesting technology which is being sought as a potential way to provide the broadband last mile for the information superhighway.

5.3. *Law and regulatory matters*

China has still not yet developed comprehensive telecommunications law and regulatory policy. Tremendous efforts have been put forth by the State Council to legislate the laws. As of now there is still no clear evidence for the establishment of a solid regulatory environment to host the competition in the telecommunications services. The most serious issues facing the second operator are the network interconnection and tariff scheme. The problems have been very well recognized. However, the solutions are still far-reaching.

5.4. *Foreign participation*

Facing with the restrictions of laws on the one hand and the compelling problems of telecommunications development on the other, a framework for the investments of foreign capital as illustrated in Figure 1 has been devised. The first step is to establish a sino-foreign joint venture between the foreign operator and a Chinese corporation. The choice of the Chinese corporation will be an important issue. The joint venture company will be responsible for the network construction and financing on a full turnkey basis. It thus provides a vehicle for the foreign capital investment in the networks.

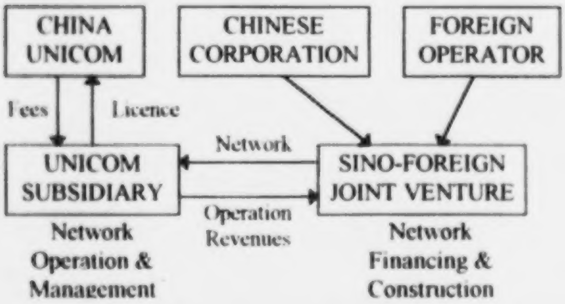

Figure 1 A framework for the foreign participation in telecommunications

There are two telecommunications licence holders namely China Telecom and China Unicom. China Unicom is chosen for the illustration in Figure 1 because it is already cooperating with many telecommunications operator through such arrangements in its GSM networks. The second step will be the cooperation between the joint venture and a subsidiary of one of these two licence holders. There are of course many variations and individual characteristics in this form of cooperation. Generically, the network will be transferred to the subsidiary entity for the management and operations. The revenues from the operations will be shared between the China Unicom and the joint venture company. Similar models have been used in Philippines, Indonesia, Thailand. The financial consideration in this approach will be whether or not the operations revenues paid back to the foreign operator via the joint venture will be sufficient to justify the investments into the network construction and financing while considering the risk of not participating in the direct management and network operation.

The list of foreign operators that have employed this approach to cooperate with Unicom is quite extensive: Ameritech, Bell Canada, Deutsche Telekom, First Pacific, NTTI, Singapore Telecom, Telstra etc. (to name only a few of them in an alphabetical order). Other forms of cooperation are also plenty. In the realm of Internet, US Sprint has won the contract to interconnect the CERNET with the world's Internet. The interface is achieved by routing through the public digital data network of MPT (CHINADDN) at a transmission speed of 128 kbps. IBM has cooperated with JiTong in the Golden Projects. These types of developments will certainly lead to further influence of international telecommunications community on China's telecommunications industry.

6. Summary

The telecommunications industry of China has just progressed into its present duopoly competition environment from a state monopoly that had lasted for over 4 decades. The key players directly controlling the industry will be MPT and MEI. Surrounding these two ministries, more and more state enterprises and even private corporations are emerging into the telecommunications service operations. Although the Chinese laws do not allow foreign enterprises such a direct participation in the operation and management of networks, indirect means for the investment of foreign capital into network construction and financing has been employed.

It has been speculated that the roles of foreign operators will be gradually expanded, and their influence on the future advancement of China's telecommunications industry enhanced. In fact the author has argued that it is necessary to utilize foreign capitals in order to attain the pace of development that will be required to accomplish the goal of a nationwide telephone penetration rate of 10% by the year 2000. This means adding 10 million telephone lines each year, and costing a total investment of over 10 Billion US Dollars. To achieve this goal, it will be necessary to grant a greater extent of foreign participation in the operations.

The potential for the future development has been demonstrated through a detailed examination of the radio paging, cellular communications, information superhighway, internet, convergence. The technological innovations will play a key factor in the success of competition in the future. For instance in the wireless communications segment, the scarcity of spectrum resource will be an impetus to develop means for enhancing network capacity. Even in the basic services, wireless technologies are in the process of being utilized for the access network. Broadband hybrid fibre/coax networks are being considered as the future technological choice for providing the last mile for the information superhighway. Overall speaking, technological options will be of paramount importance.

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Overview of Opportunities in China's Wireless Market

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1. Abstract

The growth of wireless sectors has been at the forefront of China's overall telecommunications development. As the Ministry of Posts and Telecommunications and Unicom both construct networks, opportunities for infrastructure and handset equipment continue to grow especially for paging, digital cellular and wireless local loop.

The development of China's telecommunications market has been phenomenal. According to China's Ministry of Posts and Telecommunications (MPT), as of October 1996, China's public switching capacity reached 84.6 million lines, an increase of 12.96 million lines from the same time in 1995. The number of MPT paging subscribers increased from 5 million in the end of 1993, to 17 million in the end of 1995. Growth in China's telecom sectors has not only followed, but surpassed the impressive economic growth that China has experienced in the last few years (Figure 1). Due to China's law against foreign involvement in telecom operations, opportunities in China's telecom market are primarily in equipment supply.

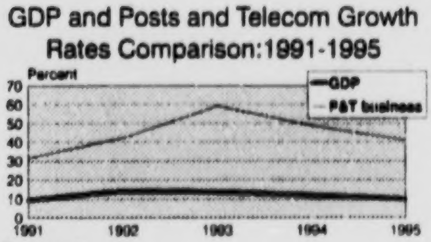

GDP and Posts and Telecom Growth Rates Comparison:1991-1995

Figure 1

This paper will examine the creation and the activities of Unicom, which is a major cause of the expanse of opportunities in China's wireless sectors. In addition, it will examine the market status and opportunities of specific wireless sectors including: paging, cellular and wireless local loop.

2. China Unicom

Competition entered the Chinese telecommunications market with the formation of Unicom. China United Telecommunications Corporation (China Unicom) (also referred to as Unicom or Liantong) is China's second public telecommunications operator. Founded on July 19, 1994 as a state-owned corporation approved by the State Council, China Unicom ended the Ministry of Posts and Telecommunication's (MPT) monopoly over the provision of public telecommunications services. China Unicom was formed by the Ministry of Electronics Industry (MEI), Ministry of Electric Power Industry (MEPI), and Ministry of Railways (MoR). Thirteen large Chinese companies are also share holders in China Unicom. China Unicom's telecommunication services are subject to the laws, regulations and rules developed and supervised by MPT.

The stated objectives argued in favor of the establishment of China Unicom were 1) to deepen telecom reform in China, 2) provide local telephone services in areas where the MPT's PSTN network does not cover or where capacity is severely limited, 3) open up the unused capacity of and capability of existing private networks to the PSTN through market driven re-adjustment and re-engineering, and 4) accelerate the development of China's telecom infrastructure and industry.

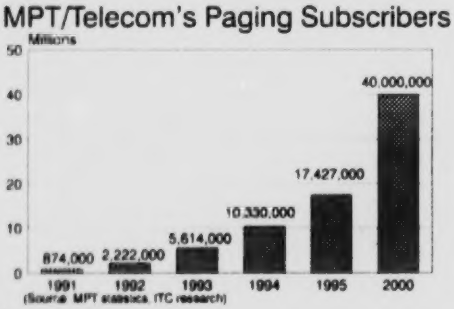
2.1 Future Plans

China Unicom's updated development plan for the year 2000 include goals in these wireless areas:

- Complete its national paging network, providing capacity for 10 million subscribers.
- Construct local telephone networks and mobile telephone networks in all main cities throughout the country reaching 7-8 million local fixed line phone subscribers and 2.5-3 million mobile telephone subscribers.

3. Paging

By year end 1995, paging networks under the auspices of the MPT had approximately 17.4 million subscribers across China. This is a 68% increase over 1994, or over 7 million new subscribers. In 1993, China's paging market was liberalized. Upon receiving an operating license from the MPT, operation was permitted.


MPT/Telecom's Paging Subscribers

(Source: MPT statistics, ITC research)

Figure 2

3.1 Paging Networks

In January 1996, China adopted Motorola's FLEX as its national paging standard. POCSAG remains in use, but in many instances is being upgraded to FLEX which has 30 times the customer handling capacity of POCSAG. By the end of 1996 there are expected to be a total of 33 FLEX systems installed across China: 22 local systems, 1 two-city system, 8 province-wide systems and 2 national systems. The transmissions frequencies that nationwide paging networks utilize include 152.650 MHz, 151.350 MHz and 150.725 MHz.

Nationwide roaming capabilities are being established in China. Limited roaming services started in April 1996 covering 272 cities. Beijing Asia Pacific First Star Communications Technology (BAPFST) selected Ericsson in 1995 as a core supplier for the first nationwide paging system in China. The first phase of the build out extended the network to 45 cities in 10 coastal provinces. Beijing CATCH, China's largest paging operator after the MPT, recently signed a Letter of Intent to form a joint venture with AVIC Group, to develop a nation-wide paging system in China. AVIC Group will provide financing for the expansion of the paging network which is projected to contain 100 paging stations and 3 million subscribers by the year 2000.

3.2 Paging Equipment

Pager sales surpassed US$960 million in 1995. There are at least 50 paging models on the Chinese market, including numeric, alphanumeric and Chinese Character Display (CCD). The sales ratio between numeric and CCD pagers is 4:1. Numeric pagers range in price between US$60-US$100, with average retail costs having dropped 50% over the last 5 years. CCD pagers cost US$130 and up. Many of the Chinese character pagers allow the caller to leave oral messages with the paging service provider, which are transmitted and then displayed on the pager screen in Chinese characters. Monthly subscriptions to a regional paging service are approximately US$3 in major cities, with annual fees averaging between US$36-US$72.

Foreign brand name pagers continue to dominate the Chinese paging market. Foreign telecommunications companies involved in China's pager market include Motorola, NEC, Casio and Panasonic. While trying to cater to these categories, many Western telecom companies are realizing that Asian customers have distinct tastes from Western customers. Pager manufacturers have found that colorful and streamlined pager models are the most popular in Asia. The number of Chinese manufactured pagers is also increasing. One highly-successful model, manufactured in Shenzhen, is the Jiamei JM-186.

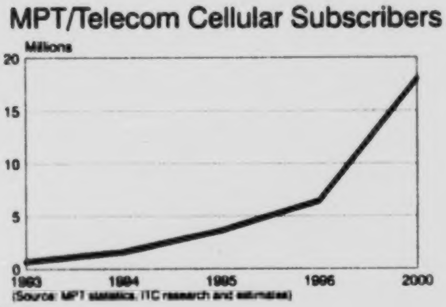
3.3 Forecast-Opportunities

Forecasts of China's paging market by the year 2000 start from 40 million subscribers (Figure 2). If China were to reach a paging penetration rate of just 6 percent by the year 2000 (up from the current 2.5 percent) China would have a paging subscriber base of 78 million. The crux of continued market expansion relies in part on providing new services and products in areas with already relatively high penetration rates. The regions in which the paging industry is strongest are the Pearl River Delta, the Yangtze River, and Beijing/Tianjin. These areas account for more than 50% of China's paging subscribers. Manufacturers hope to market leading CCD pagers, and someday voice pagers, to customers who already own a pager, but want to upgrade services.

Market augmentation also depends on successfully accessing new customers in underserved and unserved regions. Paging manufacturers hope to market inexpensive numeric and alphanumeric pagers, to untapped paging markets in rural and less developed urban areas. As in many emerging markets, paging in China has largely been driven by a lack of fixed wire infrastructure. In areas where phone installation waiting lists are long, some people opt to purchase a pager in lieu of a telephone. Under these circumstances, the customer's perception that a pager's main function is not merely notifying the receiver that someone wants to contact them, but also to directly receive messages, is a key to future growth of the paging market.

4. Cellular

China's cellular market has grown at incredible rates. Cellular networks were first deployed in China in 1987. These analog networks located in Shanghai and Guangzhou had a combined initial subscriber base of less than 1,000. By mid-1996, China had 5.62 million analog and digital cellular subscribers, an increase of 1.74 million in 7 months. In 1995, cellular subscribers totaled 3.62 million, of which, GSM network subscribers accounted for between 150,000 and 235,000 customers. GSM networks present great opportunities as they are being deployed by both MPT and Unicom. According to China's MPT, out of a minimum of 2.5 million cellular phone subscribers predicted to be added during 1996, 1/3 will be on GSM networks.


MPT/Telecom Cellular Subscribers

(Source: MPT statistics, ITC research and estimates)

Figure 3

4.1 GSM Cellular Networks

As both operators construct GSM networks, competition between MPT and Unicom has greatly influenced China's GSM market. The presence of two major operators has caused: greater opportunities for equipment suppliers, a reduction of fees, and expansion of roaming coverage. As of August 1996, MPT had deployed GSM networks in 23 provinces in China and expects to construct GSM networks in all of China's 30 provinces by the end of 1996 or early 1997. In the Ninth Five-Year plan, MPT targeted the it would reach 18 million cellular subscribers by the year 2000 (Figure 3). This figure is now viewed as conservative. Unicom's competitive strategy as China's second carrier is to focus on high capacity cellular networks and highly populated urban areas. Unicom's first GSM networks were launched in Beijing, Guangzhou, Shanghai and Tianjin in 1995. As of mid-1996, Unicom had expanded GSM coverage to include: Sunde and Nanhai. According to Unicom sources, the company plans to have expanded its GSM coverage to 48 cities by the end of 1996. Unicom's goals include reaching 2.5-3 million GSM cellular subscribers by the year 2000.

4.2 Cellular Equipment

Annual sales of mobile telecommunications products in China are expected to top US$2.5 billion (20 billion yuan) over the next five years. The total number of mobile phone handsets sold during this period is expected to reach 2.6

million per year, with GSM handsets accounting for an excess of 850,000 units annually. Competition between handset manufacturers will intensify as handset prices continue to drop. The Chinese market has experienced decreasing prices for both digital and analog handsets. Currently prices for many analog and digital handsets overlap. As of February 1996, GSM handset prices in China averaged between US$840 (7000 yuan) and US$1080 (9000 yuan). By June 1996, prices listed by a Beijing distributor for GSM handsets ranged from US$575 (4000 yuan) to US$780 (6500 yuan). From the beginning of 1994 to the end of 1995, the price of analog handsets dropped by more than half, to between US$360 (3000 yuan) and US$840 (7000 yuan). Current prices for analog handsets average between US$340 (2850 yuan) and US$820 (6800 yuan).

Currently the Chinese cellular handset market is dominated by foreign manufacturers with foreign products holding a 90% market share. The main manufacturers are: Motorola, Ericsson, Nokia, NEC and Siemens. China's leading domestic manufacturers and suppliers of cellular equipment have been unable to obtain a sizable market share. Setbacks to domestic development and production of Chinese mobile handsets include factors which hinder China's overall development of high-tech industries. Some of the problems faced include: a dearth of advanced research, minimal development budgets, overly bureaucratic production structures and incomplete product lines.

A few Chinese domestic companies are emerging onto the cellular scene. One such company is Jinfeng (Golden Bee) Wireless Telecom Corporation, a company founded in early 1995 by eight companies under the auspices of Ministry of Electronic Industries (MEI). The founding companies include: Changhong Electronics Plant located in Sichuan, Changling Electronics Plant located in Hubei, Beijing Huaxun Telecommunications and Beijing CATCH Telecom. Jinfeng's focus is to break the dominance of foreign firms in China's cellular market in the production and sales of wireless equipment, particularly handsets. However, Jinfeng is competing not only with wireless equipment produced by foreign companies, but also with joint ventures, many formed by MEI's rival, MPT, or one of its affiliates.

Other Chinese companies are responding to the lack of domestic production of GSM equipment due to a paucity of advanced technology by forming Sino-foreign joint ventures. In addition to joint ventures, many domestic manufacturers have signed licensing agreements with foreign companies. Both of these arrangements concern many foreign companies, who worry that the long term result of these relationships is the creation of new competitors. However, the alternative of going it alone presents the likelihood of extremely limited market access.

Following are a sampling of cellular equipment Sino-foreign joint ventures and licensing agreements.

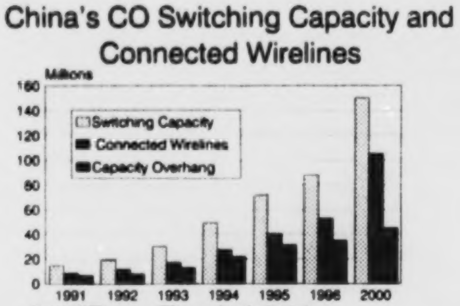
- Shanghai Bell Alcatel Mobile Telecommunications Co., a joint venture established in 1995, has the capacity to engineer, manufacture and install GSM equipment including base station transceivers, mobile switching and handsets.
- Beijing Nokia Mobile Telecommunications Ltd. a joint venture between Nokia and Beijing Telecommunications Equipment Factory 506, under supervision of China Posts and Telecommunications Industry Corporation (PTIC), manufactures digital and analogue handsets for both GSM and E-TACS systems and GSM base stations. The handsets are sold nationwide in China.
- Hangzhou Telecom Equipment Factory (HTEF) is licensed to produce and distribute Motorola GSM equipment in China. HTEF's main products include; cellular phones, cellular phone base station system equipment and medium and high capacity digital controlled exchanges.

4.3 Forecast-Opportunities

China's cellular market is expected to grow by close to 15 million subscribers within the next three years, creating many opportunities for both GSM cellular infrastructure and handsets sales.

Outside of GSM, CDMA networks and the possible introduction of PCS networks will broaden opportunities for mobile equipment suppliers.

5. Wireless Local Loop



(Source: MPT statistics, ITC research and estimates)

Figure 4

Given high market demand for phone service and unused switching capacity among other factors, China is considered one of the largest potential markets for wireless local loop (WLL). WLL is a cost effective complement to, and in some cases substitute for wireline installations. Demand for WLL is difficult to pinpoint, especially while WLL is still in its infancy. However, WLL demand is reflected in overall demand for telephone service. Calculations by Phoenix Wireless Group, a WLL equipment provider, show that WLL deployment is attractive for between 15% and 35% of a typical telephone network.

5.1 Market Factors

Determining specific cases in which employing WLL may be advantageous requires careful analysis. Key factors affecting WLL applications include: system cost, time to market and mobility of system, and spectrum allocation. A number of other regulatory, technical, and economic factors must also be considered, including population density, distribution and projected growth; anticipated network growth; availability of existing infrastructure; service requirements; life-cycle costs and geographical characteristics. Even environmental factors, such as the amount and frequency of precipitation, which can interfere with radio transmissions, must be examined.

Estimations of WLL systems costs to both operators and customers varies greatly. Industry analysts maintain that per-subscriber costs for WLL systems currently average between US$700-$900, with some quotes as low as US$450. In China in 1995, the average urban per capita annual income was US$516 (4,288 yuan) and the average rural per capita annual income was US$190 (1,577 yuan). Urban residents, with higher income levels, will have a greater ability to pay for basic services. However since WLL is most economical as the distance between the point of presence and switching office increases rural applications are often more profitable for the operator. Equipment prices may have to decrease for rural populations to be tapped for WLL.

An advantage of deploying WLL is speed of installation. Compared with copper wire systems, WLL technology allows faster network set-up and greater planning and deployment flexibility. Given MPT's goal of hooking up subscribers as quickly as possible, WLL technology is well suited for the PRC telecommunications environment. For a network deployed in Fujian, Motorola's Wireless Access Division installed a CDMA fixed wireless network within 10 days of equipment delivery. The mobility of WLL systems is also very advantageous. Phoenix Wireless Group, which has supplied over 30 wireless local loop systems throughout China, moved one of its WLL systems from Jilin Province to Hebei Province. WLL systems can also provide a quick solution to a missing link in an existing telecom infrastructure or at the site of an emergency.

As with all wireless technologies, operators of wireless local loop systems must receive spectrum allocation and efficiently utilize finite radio frequency resources. In China, wireless local loop systems have yet to clear the first hurdle of spectrum allocation. The State Radio Regulatory Commission (SRRC) has the power to allocate radio frequencies. SRRC has considered using 1.5 Ghz and above, as well as the 400 MHz-500 MHz range and the 806 MHz-823 MHz trunk radio band as possible radio frequencies. However no final decision has been made by the SRRC. Other obstacles to a WLL standard are the military, which controls its own radio spectrum outside of the SRRC's jurisdiction and local governments, which can exercise a great deal of independence over radio frequency control. What could emerge is a patchwork of protocols that could be allocated either by the military or local governments for WLL applications. Additionally, there is the possibility of these organizations initiating or deploying WLL systems on their own. The absence of a standard allocation for WLL has led some potential participants in China's WLL sector to wait on the sidelines until such issues are resolved

5.2 Network Trials and Equipment Production

In fact, deploying trial systems and entering into local production agreements are some of the strategies companies are utilizing to position themselves in China's potentially huge market for WLL. For example, Nortel is supplying equipment for a WLL trial being executed in Inner Mongolia by the BUPT-Nortel Telecom R&D Center. Motorola and DIVA Communications Inc. are both in the process of establishing in-country supply arrangements with Chinese companies. Motorola Cellular Infrastructure Group signed an MOU with Xian Datang Telephone Co. to work together to provide cellular and WLL base station and switching equipment to Chinese operators. The MOU includes Motorola's CDMA technology and Datang Telephone Co.'s SP30 switching equipment. DIVA Communications Inc. is currently negotiating a deal with Beijing Wire Communications Plant (BWCP) to jointly develop switch interfaces between DIVA-2000 WLL equipment and the CO switches manufactured by BWCP. Diva and BWCP are also pursuing BWCP's role as a distributor for Diva in China, promoting and supporting sales of the DIVA-2000 WLL.

WLL appears to be a viable answer for China's telecom development goals and needs, due to China's unused switching capacity and the deployment versatility of wireless local loop. WLL technology may prove cost-effective in China's high-growth urban areas, sparsely populated rural regions and areas, such as the Pearl River Delta and the mountainous sections of Sichuan Province, where hard-wiring proves difficult. Despite the numerous studies and projection championing the enormous potential of China's WLL market, several governmental and economic factors must be resolved before WLL can become a major component of basic telecom service.

6. Conclusions

The entrance of a Unicom, a second carrier, is one factor that has augmented the opportunities in China's wireless sectors. Paging and cellular sectors are both sites of great expansion, with local, provincial and national networks being deployed. Wireless local loop applications, while still in trial stages, are a good match for China's unused switching capacity and long waiting lists for basic phone service. Equipment supply, both infrastructure and customer premise, is the hottest area for foreign companies involved in China's telecommunications market. As more companies enter the China's telecom market, involvement in joint ventures, licensing agreements and technology transfers will be necessary for companies to achieve sufficient market access.

Heading Towards "Informatization":
China Faces Dilemmas and Challenges

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Abstract

In its rigorous drive for informatization, China is engaged in political and regulatory dilemmas and challenges. The application of advanced communication technologies empowers the country to enter the information age, but it also imposes new and complex issues on China. What visions, strategies and policies the Chinese government will take to handle these issues remains a difficult question.

Prelude

Since the early 1980's, China has been distinguished by two important movements: internal economic restructuring, which featured economic liberalization, decentralization and marketization, and opening up to the outside world, which has resulted in a large inflow of foreign investment and a boost of foreign trade. China's economic advances have been paralleled by a spectacular "revolution" in communications and information, or "informatization," as is put by the Chinese government. This revolution is particularly characterized by the country's development of telecommunications. National teledensity has increased from 0.4% in 1980 to 5.47% in the middle of 1996, capacity of telephone exchange from 4.4 to 96.3 million lines in the same period of time. During 1990-1995, growth of telecom services revenue has been averaged 45% per year, three times greater than the nation's GDP annual growth. Substantial investment, fast expansion of existing networks and services, and expeditious upgrading of technology(1) have given China better communications capabilities and greater access to information resources.

Technologically, China's efforts for the advances of communications and information are targeting at:

- Cross-country computer communications networks, with high speed and sufficient capacity for the transmission and processing of information
- Wired and wireless, fixed and mobile, telecommunications networks to provide national network backbones with advanced technologies, such as ATM and SDH, for basic telephone and value-added services
- Application of integrated digital technologies for interactive multimedia services
- An international communications network system based on submarine fiber-optic, digital microwave, and satellite communication technologies
- Technology innovation: transformation of traditional switching and transmission technologies (e.g., manual control, analogue) to modern advanced technologies (e.g., digitalization of data transmission and processing)

Government Impetus for the "Revolution"

The key drivers behind China's information revolution include economic benefits, market forces, political and managerial requirements, and the state preferential policies in tax, loans, capital investment, equipment depreciation, and use of foreign exchange. The Chinese government has recognized that the country's ability to sustain its economic growth is essentially contingent on its capacity to develop and upgrade the national communications infrastructure: a sturdy national communications network is vital to China's socio-cultural, political, and economic development, because "a well-planned, skillfully managed and effectively operated communications system contributes to economic and commercial growth, to government efficiency, and to the dissemination of information required for the attainment of educational and social goals as well as for the enhancement of the national culture."(2)

The central government understands that "the nation's modernization efforts demand that every aspect of the communications and information sector, from efficient daily communications and component manufacturing, to system engineering and design, and network management and finance, be brought up to date."(3) Beijing's enthusiasm for communications development is also a reflection of its concern about the weakening of the national political and operational control caused by the growing economic decentralization, the central government needs to have a highly effective information system to keep track of geographically dispersed and politically sophisticated activities. The official recognition of the importance of information and communications can be highlighted as follows:

- Information and communications is a key factor for China to improve its economic efficiency of resources and technology, and to enhance the country's overall ability to compete in the world.
- It is a support function and a strategic asset for government command and control, and for policy and decision making processes.
- It is an effective tool for building up a well regulated nationwide market system.
- It is a stimulator for the enhancement of cultural and educational activities.

Policy Dilemmas: To Inform, To Control, or Both

Despite all the benefits and advantages they can bring to China's economic progress, modern information and communications technologies are at the same time a cause of apprehensiveness to the Chinese government. Although information technologies are essential to the nation's economic strength and competitive position, the government still considers information industry as far more sensitive than any other industries, therefore, it must be strictly regulated and controlled. The challenge to the government is simply rooted in a political and ideological contradiction. To implement the nation's modernization program, the government priority must be given to the development and application of information technologies, which implies providing the general public a wider and easier access to information, linking China's 1.2 billion people into a modern communications network, and giving individuals more freedom in the use of information resources. This, however, raises an important issue: will information technology ever goes so far in China as to undermine national unity and bring about a society beyond the government control?(4)

The Chinese government concerns are based on the official view that information and communication is the nation's nervous system that involves the nation's security, stability, and sovereignty, if the massive Chinese directly hook in via computer networks to each other and to the outside world without any appropriate restraints or protection, the country's social order could be impaired, the basis of Chinese ideology could be loosened, and the nation's fine cultural values contaminated.

This is why the central government has been seeking ways to supervise and monitor information over the Internet, such as setting up technical barriers to certain news groups or pornographic materials(5) and applying technologies (e.g., firewall and encryption software) to selectively steer, oversee, or filter out information. It also accounts for the official determination to maintain control of telecommunications: all cellular telephones, pagers, radio trunked equipment, and similar electronic devices must be registered; all telecom business ventures must be approved; and foreign equity or operational involvement in China's telecommunications networks must be banned.(6) Access to international computer networks is tightly restricted and foreign firms' operation of information services in China is held off. Information society, in the Chinese official interpretation, is the *national economic informatization,* which means the application of electronic information technology in China's national economic development. Information equipment manufacturing, information transmission, and information services should be primarily geared for economic, business, science, technology, education, healthcare, and industrial management.

Instances that have aroused these concerns include the use of satellite dishes for overseas TV programs, proliferation of short-wave radios to reach foreign broadcasts, and the free flow of information by facsimile machines, electronic mail, and most significant of all, the global computer information network, the Internet, as the transmission of messages through these technologies is very difficult to monitor or check. In many cases, the matter appears more serious, because the government efforts to regulate or control the use of these technologies are confronted or obstructed by the political and commercial interest of different government organizations or state-run businesses.

"Problematic Zones"

China's political dilemma of free flow of information and government control is briefly manifested in three aspects: use of Internet, control of telecommunications, and the efforts to regain domination over economic and financial information at home.

1. Internet

As Internet becomes increasingly available to the Chinese general public. The government is increasingly concerned about the harmful materials, or information trash, as officially put, carried in the Internet networks, which may cause social disturbances and contamination of the public values. On one hand, it sees Internet as a good source of information exchange for China's development of science, technology, economy, and education, and for the world to understand China. On the other, it is cautious of whether or not and how much the Internet will jeopardize the nation's security, stability and sovereignty, if the flow of information is unchecked. The government concluded that it is imperative to formulate policies and regulations to ensure the due management of the Internet in China and healthy information exchange because pornography and unwanted information penetration may strongly and negatively affect China; it is necessary to develop new mechanisms to control Internet and ultimately build a centrally administered monolithic backbone network, which can be used to minimize the negative effect of the Internet on China.(7) The government has maintained a vigilant attitude when it works vigorously to bring the country into an *economically* informatized society.

- **What to Do?**

Since the late 1995, the central government has attached special importance to the control and management of Internet use in China, in an attempt to regulate the market and to screen out pornographic and anti-government information.(8) In April 1996, the State Council declared the establishment of a new task force called the National Informatization Leading Group,(9) a body in place of the previous National Joint Committee for Economic Informatization, which takes the responsibilities of making national information policies, coordinating different government organizations, and overseeing the operations of China's communications networks and services.

The State Council Directive (#195, issued in January 1996) and the MPT regulation (issued in April 1996) ruled:

China's public Internet-connected networks must be planned, constructed, operated, and managed by the Directorate General of Telecommunications (DGT) under the MPT, and all international Internet access must go through the external gateways exclusively provided by DGT in Beijing, Shanghai, and Guangzhou. In addition, the Ministry of Electronics Industry, the State Education Commission, and the Chinese Academy of Sciences are the only organizations authorized to provide nationwide Internet services for eligible users (their international access must also go through DGT's public gateways, no other channels, including satellite communications channels, can be used for international connection). The construction of all the new networks which will be connected with the Internet must be approved by the State Council. Both local access providers and service subscribers(10) of the Internet must provide the MPT with the information on the related technical specifications, number of the network mainframe computers, domain naming system (DNS), purpose of using Internet, and subscriber background for registration and approval. Accordingly, China's networks will be controlled and managed at three layers:

1) The networks authorized to be directly connected with the Internet in China, which are run by the State Council approved organizations: the MPT (DGT)'s ChinaNET, the Chinese Academy of Sciences' CANET, the State Education Commission's CERNET, and the networks run by the Ministry of Electronics Industry or its incumbent entities

2) The networks officially permitted by the related authorities to have access to the Internet through the MPT international gateways.

3) Local connection networks which must be approved by the related local organizations. The approval is based on the eligibility or qualification assessment on operating personnel, facilities, services and safety.

The network operators that plan to establish networks for linkage with international networks must meet the following criteria:

a) Officially recognized as holding a legal person status

b) Equipped with officially accepted computer information networks, facilities and management personnel

c) Operating with good safety and security control systems and technical protection measures

d) Meeting other requirements specified by relevant rules and regulations set by the State Council.

The third planned international gateway in Guangzhou,(11) part of the ChinaNET project, was said to have been suspended by the State Council in December, 1995. That is, international Internet gateways are currently limited to Beijing (128Kbps) and Shanghai (64Kbps). Meanwhile, China is planning to use encryption and fire-wall technologies(12) to control or selectively monitor the information transmitted through the Internet in China, with the claimed objective of defending unauthorized Internet access and safeguarding network security. All computer network (Internet) users are currently required to apply to the MPT local branches (PTAs) for approval and register with public security organs within 30 days of connection, sign an agreement promising not to engage in illegal activities, and report if they switch to other service providers or cancel their links.

In addition to imposing limits and regulations on public Internet access providers and service subscribers, the central government will most likely take technological measures to oversee and check the operation of the Internet in China,(13) which include using advanced information technologies to selectively screen, monitor, or filter information, and implementing a system of surveillance to keep track of service subscribers.

• Making Impossible Possible?

Technological or political and regulatory, these measures may turn out as more of a wishful thinking than realistic tools for the Chinese government, because the application of advanced communication technologies based on real time, fiber optic, digital microwave, and satellite systems will make it very difficult to build a national (and international indeed) information infrastructure which *can* be highly controlled and strictly disciplined. As a matter of fact, China's ability to control information has been steadily weakened by

(1) the interest or goal disparities among different government organizations that have significant stakes in information and communications industries (e.g., MPT, MEI, etc.);

(2) the state initiatives in installing most advanced digital networks and facilities which enable people to have increasingly easier and more open access to information;

(3) the competition of MPT and many other Chinese business entities to cash in on information services; and

(4) the very nature of the Internet: decentralization

and distribution, which makes it possible for the Chinese Internet users to get around the official control.(14)

For better or worse, Informatization of the Chinese society will offer the government effective instruments for political, administrative, and managerial purposes, at the same time, it will also empower individuals in their pursuit of greater personal freedom. Conventional notion of political control by merely restricting or blocking the channels of information flow may no longer work, particularly in times when people have more and more access to available technologies to transmit, process, use, and even generate information by themselves. Technological complications and political controversies will soon place the Chinese government onto a crossroad, at which a fundamental and strategic choice must be made for the nation to further develop its information and communications. It seems no question that the Chinese government will, within a foreseeable period of time at least, maintain its control of information and communications, but the question is whether this control will be feasible, and to what extent it will be maintained.

2. Economic and Financial Information

In line with the official concerns about the Internet penetration, In April 1996, China reasserted the official decision made in January to control foreign economic information services: all economic and financial information in China will be subject to the control of Xinhua News Agency, (15) the official news organization of the Chinese government, which would examine information provided by foreign press simultaneously, not prior to release, filtering out the information slandering China or jeopardizing China's national interests.

Following the State Council's directive, Xinhua outlined its firm content controls: neither organizations nor individuals are allowed to engage in activities at the expense of state security and secrets; no one is allowed to produce, retrieve, duplicate, and distribute information that may cause social disorder, or spread obscene and pornographic materials. Under these rules, foreign news agencies must apply in writing for permission to distribute economic news in China. They must provide the details on the sort of information they publish, how they distribute it, how much they charge, and the names and addresses of their clients in China. Users must apply in writing for permission to receive the information, explaining what information they want, how it will be used and how they will receive it. Although Xinhua said the rules, effective immediately, were designed to safeguard state sovereignty and protect the legal rights of the users of the business information inside China, two other factors might better justify the proclamation of these new rules:

1) *Control of Information* The central government saw an increasing loss of control over information disseminated by the information wires, and thus wanted to take measures to tighten reign over the explosion of the electronic information services and to regain its former monopoly power. The new regulation may also have been a reflection of the political controversy between the reformists who support open market and more liberal political environment and the advocators of re-achieving traditional centralized authority. Further, Xinhua control will give power back to the government, whose perception is that media should act as a form of education and provide guidelines for correct thinking and behavior, not merely as a channel for news and information release.

2) *A Cash Grab by Xinhua* Xinhua has been unable to compete with the efficient real-time information services like Reuters, Dow Jones-Telerate, and Bloomberg, due to Xinhua's shortage of financial resources,(16) physical and technological limitations of its networks, and its restricted and less efficient channels of information. Under the new rules, Chinese banks, brokerages, and other organizations that need economic and financial news, have to pay Xinhua subscription fees for the information service, allowing Xinhua to relax the financial pressure it faces, and extract a larger share of profits from the lucrative information business.

3. Telecommunications

For many years, China's telecommunications services have been closed from foreign entries. The country's telecom network equity ownership and network operation have been strictly controlled by China's Ministry of Post and Telecommunications (MPT). Direct foreign investment in China's telecom services have been explicitly prohibited. MPT minister has constantly reiterated on different occasions that the Chinese government is unlikely to relax this policy, at least for a time period before the year 2000. The official justifications given include:

- Telecom network operation concerns China's national security, integrity, and sovereignty
- China's premature telecom market conditions: incomplete market regulatory framework and lack of national telecom law
- China cannot compete with foreign players on an equal footing, because of its current disadvantage over capital, technology, and management expertise
- Unclear assets ownership status of the Chinese telecom enterprises, which may lead to asset drain or invisible privatization if foreign firms become involved

Political and economic factors have played a decisive role in prohibiting foreign involvement in China's telecom network operations. In the Chinese view, telecom network systems are very sensitive and critical to the nation: they must be well protected and should not be exposed to potential dangers or risks. Likewise, telecom services, a "cash cow" for the MPT and the government, must be kept intact to its "owner", not to be shared with foreign profit seekers. However, facing a huge demand for rapid growth and expansion, a growing market complexity, and a strong competition for foreign funds and technologies, the Chinese government has been seriously pressured by a policy dilemma of retaining control over telecom networks or gradually relaxing its long-held reigns.

Issues and Problems: Calls for Action

In applying modern information technologies to serve commerce, business, or government, China is still at a beginning stage, but the country's strong incentives and striking movement towards electronic communications and information age are perhaps second to none in today's world. China has the advantage of leapfrogging some phases of technology and regulatory development, which took years for other countries to go through. Besides, the country has consciously attached great importance to four fundamental elements of the information society in its informatization campaign, i.e., advanced communications network, computer hardware and software, information resources or database, and people who innovate and operate modern technologies. However, China is increasingly challenged by a new political, legal, management, and international environment which makes the conventional idea of information and communications obsolete. The listed issues and problems China currently faces are of great significance to the country's progress, and therefore, must be addressed with strategic insight.

- *Infrastructure*: where should the limited resources be allocated; what technologies should be adopted
- *Network management and control*: centralized, distributed, or a mix of both
- *Proprietary right of information*, as related to sharing of information resources among government agencies and business enterprises
- *Coordination and balancing* for different interest groups which have major stakes in information and communications industries
- *Foreign involvement*: to what extent and degree should the country adopt foreign investment and technology; how will China's domestic information and communications industries be supported to grow and compete with overseas companies
- *Legal framework*: what measures should China take to facilitate the process of information and communications law making; how can the laws be made and enforced to accommodate the Chinese circumstances and meet the needs for information globalization

Endnotes

(1) About US$26.82 billion was invested between 1991 and 1995 for telecom infrastructure development (Source: Chinese MPT). By 1995, 94% of the exchange had been automatic program

controlled, and 84% of the long distance exchange had been digitalized; telephone services had been expanded from plain and basic services (POTS) into a spectrum of different types based on wired and wireless technologies. ATM, SDH and other advanced technologies have been put to experimental operations.

(2) Mary G F Bitterman, "Improving Quality of Life with Telecom and IT," *Transnational Data and Communications Report*, November-December 1992, 11.

(3) Ken Zita, "Telecommunications: China's Uphill Battle to Modernize," *The China Business Review*, November-December 1989, 18.

(4) The Chinese government has consistently expressed its concern over the impact a free flow of information may make on social and political stability, as well as on national security and sovereignty. It indicated in the regulation on China's Internet linked computer networks (April 1996) that neither organization nor individuals are allowed to engage in activities at the expenses of state security and secrets; no one is permitted to produce, retrieve, duplicate and spread information that may hinder public order, or contain obscene and pornographic materials.

(5) Li Xing, a member of the CERNET Technical Board and professor of electronic engineering at Qinghua University in Beijing, was quoted by *CommunicationsWeek International* 147, June 26, 1995, 41.

(6) Mark Clifford, "Crossed Lines: Peking Policy Statement Causes Confusion," *Far Eastern Economic Review*, Nov. 4, 1993, 26.

(7) This may indicate China's effort to create its own Internet sub-system to benefit from Internet and at the same time control Internet access to the extent the government wants.

(8) *Wall Street Journal* reported on Jan. 31, 1996 that China is to be using the latest technologies such as filtering, encryption, and fire wall technologies from Sun Microsystems Inc. and other foreign companies to monitor or selectively block access to the incoming or outgoing information on Internet.

(9) The Leading Group is chaired by Vice Premier Zou Jiahua, and headed by MEI minister, MPT minister, State Council Associate Director General, vice chairs of State Planning Commission, State Economic & Trade Commission, and State Science&Technology Commission, and Deputy Governor of the People's Bank of China, with 12 members representing different ministries and departments under the State Council.

(10) China's Internet subscribers reached a number somewhere between 50,000 and 100,000 as of April 1996. Most of the subscribers are government agencies, research and educational institutions, and big business enterprises, not individuals. E-mail is of the primary use.

(11) MPT's international Internet gateways available as of early 1996 are located in Beijing (128 Kbps) and Shanghai (64Kbps).

(12) For instance, firewall software developed by Sun Microsystems.

(13) Foreign sources claim that no possibility exists for any government to successfully control information. And national boundaries are being made irrelevant by networks of capital, brain power, and information flow. China's effort to control information will never work.

(14) By 1995 China had 5 Internet connected networks built and opened for services, i.e., Network of High Energy Physics Institute, Chinese Research Network, China Education and Research Network, Beijing University of Chemical Industry Network, and MPT's ChinaNet.

(15) Xinhua News Agency is China's central government arm in exercising authorities over news releases. It has about 7000 staff members working in China and abroad. It is the empowered organization of the Chinese central government to release and control international news to China. The agency was once the dominating power of electronic international news in China.

(16) Xinhua has been heavily subsidized by the government funds.

Universal Enhanced Services

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1. ABSTRACT

The ability to combine one or more value-added services offers a powerful array of economic communications tools to access the largely untapped poorer or disadvantaged consumer markets. Telecommunications empowerment by governments to support universal service, such as virtual telephony messaging plus prepaid calling plus paging notification simultaneously, achieves greater access to and utilisation of the existing infrastructure of embedded copper or wireless networks with effectiveness and efficiency.

2. INTRODUCTION

Governments around the world are now seeking mechanisms for consumers in all regions of their nations to avail themselves of enhanced services at just, reasonable and affordable rates. Such consumers who have low incomes, or live in rural, insular and high cost areas, or are scholars, in need of emergency services and health care, or library readers should have advanced services and information services reasonably comparable to those services and rates in urban areas. It is our experience that such services could be made available in 1997 to meet the needs of these consumers and satisfy the underlying governments' intent.

Some of the enhanced services we believe should be addressed are as follows. We contend that universal service support for each of these enhanced services would not act as a barrier to entry by new competitors nor favour one technology over another, perhaps more efficient technology – provided the major network operators are not allowed to become monopolistic in their business practices.

3. INFORMATION SERVICES

Information services on telephony, transmitted to communities via satellite and to individual consumers via satellite and mobile phones. Brite is one of the largest information content supplier over telephony in the world; its telephony information services use voiced bites which are scripted, edited and transmitted in a way similar to CNN Headline News on television using video bites. With 60 journalists and 14 studios, this facility transmits its own domestic and international news, weather, sports, financial and other information content to over 200 communities around North America and to countries in Asia, such as Thailand. This information service provides about 450 program updates each and every day. There are also over 5,000 library programs on such topics as health care and medical services, automobile care, and educational subjects. Since the services are already on a satellite with appropriate footprints across the destination continents, such services can be offered to consumers in rural, insular and high cost areas with the same quality, diversity and performance as that offered to consumers in urban areas. Such services are typically delivered to a common downlink in a community, to a distribution site such as a newspaper office or a radio station to which local calls can be made on wireline phones, or low-cost calls on wireless phones.

Rates to consumers are often reduced by local advertising. Alternatively, information services can be paid for by airtime on a wireless network; for example, a newspaper and the local wireless network operator can join to provide information service to consumers on wireless phones.

4. VIRTUAL TELEPHONY MESSAGING

Messaging with virtual telephony enables low-income, rural, insular, high cost area and homeless consumers, scholars, consumers out of work or in need of protection from unwanted calls (e.g., the aged) to have a mailbox number without owning a phone – wireline or wireless. Callers communicate with mailbox owners by calling a regular number as if the mailbox owner actually had a phone. The mailbox owner can retrieve messages at will from a pay-phone or any other phone; local calls are free for a private wireline phone. This service offers the mailbox owner a professional "front" which uses an advanced service in an innovative manner; the caller simply notes that the mailbox owner is "not available" and leaves a message. Further, this service can be provided on the same system as a voice mail service to an urban subscriber – and in multiple languages to accommodate ethnic minorities. For example, on the island of Mauritius in the Indian Ocean, a single enhanced service has been installed to simultaneously provide voice mail to the urban consumers and messaging with virtual telephony to low-income, rural and insular consumers – in the same system. Brite also provides voice messaging services to smaller markets like Brunei or larger markets such as Hutchinson in Hong Kong.

Virtual telephony messaging also provides PTCs/PTTs with a solution to providing telecommunications services into areas with a low penetration of copper cable. It is also typical for consumers in these areas to be on long waiting lists for any kind of communications service.

The cost of owning a mailbox is typically one third to one fifth that of owning a phone on a monthly basis.

5. SPEECH ACTIVATION

Speech activated dialling has now been installed in several Pacific Rim regions (such Hong Kong, Singapore, Malaysia, British Columbia, California, Oregon and Washington State) as an alternative to touch-tone for one-word rapid access to the called party. With one word, such as "Office", "Emergency", or "Voicemail", a system is available to the consumer to dial the number automatically. Such word-dial string pairs are preset in a programmed speed-dial directory for each consumer on the network. The consumer can also speak "Dial 011 65 336 8048", or the like, for numbers not programmed in the directory. In the consumer's wireline environment (typically the office or home), background noise is low and speech activation is comparatively easy to implement. However, in a consumer's wireless environment (typically the moving vehicle, a street sidewalk, or a noisy restaurant), the need for effective high noise rejection is essential. This speech activation issue in wireless environments has been solved both for hand-held and hands-free operation of a wireless phone in these 70 markets worldwide. Further, it has been solved not only in American English, but also in such languages as Cantonese, Mandarin, Malay, Korean and other dialects of English around the world. In some parts of the world, access to the network using touch-tone is not possible due to the decadic or analogue nature of the network; in these situations the use of voice commands is an effective and efficient option.

At the U.S. CTIA show in March 1996, speech-activated voice mail was introduced for message retrieval in a high-noise environment – one word commands such as "Play", "Save", or "Erase" are used instead of touch-tone digits. The flexibility of this speech-activation approach to telephony usage is at least as good as the touch-tone approach. Since it is typical to expect that about 50 percent of all business calls from a vehicle are to voice mail, such as service with speech activation makes driving and touch-tone dialling unnecessary, safety and convenience a prerequisite of good driving, and "Look Mama, No Hands" – the consumer's eyes never leave the road and hands never leave the wheel while dialling is completed. Some countries already have a law which prohibits dialling and driving at the same time.

In 1995, a Hong Kong network operator introduced a Voice Directory service, which in 1996 is being emulated by MobiLink in Singapore. This "Information Link" with one-word speech-activated commands accesses financial information, emergency services, sports results, taxis and airlines, ticketmasters, and other hotline services – in more than one language. Other speech-activated services from wireline and wireless phones can be developed to be consistent with the public interest, convenience and necessity.

In July 1995, a long distance calling card service provider based introduced a card which allows the consumer to access the network from any phone, touch-tone or rotary, domestically and internationally to place a call without operator assistance. To make a call, the consumer enters a voiced password and a voiced PIN number of 5 digits; with an additional feature built into the network, this speech activation method of calling card verification is 100% accurate, because fraud is reduced using the voiceprint of the caller.

Two other services using speech activation are worthy of note: a) fraud control by the consumer entering a voiceprint word recognised only as that specific caller and a voiced PIN, and b) directory call completion by the wireless network operator being enabled to recognise wireline directory service numbers and automatically outdial that number to the required destination for the consumer, without the consumer making another dialed call. These services are already installed in Singapore and British Columbia respectively.

Touch-tone is the basis for receipt and manipulation of enhanced services. Retrieval of information, educational services, messages, and text is performed most effectively with touch-tone. However, as an enhancement to touch-tone, the use of a consumer's most common communications tool – the voice – is another service that can serve the same general function as touch-tone service. Speech-activated services should be included in a general support plan for universal service delivery. This is consistent with the public interest, convenience and necessity.

The cost of speech-activated services are now being incorporated into the base service monthly charge of a phone in some countries. However, it will require a second generation voice mail service (the most common base service today) with speech activation and personal communications features to enable speech activation to take hold with most users of enhanced services. We project that this could occur in many regions of the world before late 1997.

6. PREPAID CALLING

Prepaid calling can now be made available for both wireline and wireless phone service consumers. The principle markets in the Pacific Rim include: a) non-status or credit challenged consumers, b) transient consumers and tourists, c) those consumers with bad debt problems, d) gifts to consumers, and e) the business market where controlled payments may be preferred, such as salespersons and lorry drivers. Some Asian wireless network operators/service providers have rejected as many as 40 percent of all applicants for new service because these consumers are credit challenged; the same network operators have as many as 20 percent of their users who do not pay their monthly bill due to cashflow problems. Rather than cutting service for these users, with the prospect of losing their business, the network operator would prefer to migrate these consumers to another, prepaid calling service. The concept of this telecommunications mechanism is the same as buying petrol to drive a vehicle for an approximate mileage or paying a mortgage in advance to live for a month in a dwelling. Consumers pay for phone service in advance in one of several denominations.

Using this new service the network operator could market, from any store, a "pre-packaged" phone with an established account and prepaid minutes of usage to a consumer – an example of this is the Amigo phone marketed by Rogers Cantel in Canada. This phone does not need to be different from any other phone; however, the network switch database is programmed to know that this phone number is operable only on a prepaid account. After usage, this consumer is then notified by an automated spoken warning through a whisper, when the account balance is at a predetermined low level and requires refreshment. Such refreshment can be performed when the consumer buys a "lottery-like" disposable ticket, scratches it to reveal a number and enters the number by touch-tone or by voice over the phone to increase the consumer's account by the value of the ticket. This network can simultaneously provide prepaid services not only to low-income consumers, but also to urban and credit-challenged consumers.

An alternate service is the debit or calling card, which is more complex to use than prepaid calling. The consumer with the debit or calling card calls an 800 or free-phone number and enters a PIN or passcode to obtain approval to enter the remaining called party digits. An adjunct service is "warm billing" which enables any consumer to poll the network for a check on his/her ordinary or prepaid account balance at any time during the month. Another adjunct service is the capability to limit called numbers to a predefined small set (e.g., truck or lorry drivers are given a phone to make calls only to preset office locations or for emergencies).

The purpose of prepaid calling is to control expenditures for small businesses, consumers in high cost areas, low-income consumers, occasional users, scholars, temporaries and rental phones. The same system is applicable to both urban and rural or insular telecommunications simultaneously. A low-cost prepaid service has been introduced by Hutchinson in Hong Kong. In general, the potential for prepaid calling is facilitated by the network, such as through mobile telephone operators, residential wireline operators, pay TV operators, and Internet service providers.

The concept of prepayment is commonplace in life for most nations. We use this concept to live in a house, drive a vehicle, watch a movie at the cinema, or pay taxes at source. Telecommunications services should offer a similar prospect for those consumers unable to satisfy urban area-compatible credit ratings. This enhanced service (enabling all consumers to affordably access numerous information and emergency services, and participate in the benefits of universal service) then becomes cash-based, which should be an attraction to any network operator. This concept could also be a mechanism for collecting universal service contributions. It is also a self-regulating mechanism to limit service usage which cannot be paid for by some consumers. Standards for evaluating the affordability of telecommunications services are largely predetermined by the consumer if they are prepaid.

7. INTERNET

Internet is becoming important advanced information access to schools and libraries in all regions of the world. Through the use of appropriate firewalls it is now possible to control the type and source of information passed to scholars and readers. Internet is also an important source of information and electronic mail (i.e., "e-mail") for home-based consumers, especially as the aged become more computer-literate. Further, voice, facsimile and text messaging services are now being linked with the Internet for three primary purposes: a) e-mail notification, i.e., "you have three e-mails available" which are then picked up by a computer , b) e-mail messages, i.e., the consumer can receive in a spoken form either the title of each e-mail or the entire e-mail using text-to-speech services, or c) maintenance links to remote unmanned equipment for status checks, new software downloading or general monitoring. In 1996, another Internet service is emerging – the setup of least cost routing for individual consumer telephone calls. This service, requiring both a computer and phone, makes long-distance calls more economical for many consumers.

F. OUTSOURCED MANAGED SERVICES FOR LOWER COSTS

To extend support for rural, insular, and high-cost areas to all users, not just to urban residential users or residential and single-line businesses, we would recommend that an outsourced managed service be established to shrink time to market and to avoid the high cost of implementation often prevalent in network operators. Satellite and wireless can now access more users with more services and information content than most wireline network operators; community access costs to schools, libraries, and other local centers can also be amortised over consumers in the local community, and perhaps augmented by local advertising. Cash-based service delivery should have better appeal to consumers in these areas. An outsourced managed services operation could handle both these business issues and the marketing of these services with focus and an experienced organisation. Brite is one provider of outsourced managed services with a reputation for lower cost operations.

The ability to combine one or more value-added services offers a powerful arrays of economic communications tools to access the largely untapped poorer or disadvantaged markets. Telecommunications empowerment by governments to support universal service, such as virtual telephony messaging plus prepaid calling plus paging notification simultaneously, through outsourced managed service providers achieves greater access to and utilisation of the existing infrastructure of embedded copper or wireless networks with effectiveness and efficiency.

The SPEAKeasy Software Programmable Radio: An Opportunity for Transparent Wireless Telecommunications Standards in the Asia-Pacific Region

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ABSTRACT

SPEAKeasy is a United States Department of Defense program to develop a software programmable radio operating from 2 MHz to 2 GHz, employing waveforms selected from memory, downloaded from floppy disk or reprogrammed over the air. Key to the program is publication of specifications for the radio Open System Architecture. A joint government/industry forum is providing feedback and insight into the design. In this manner, many radio manufacturers will be able to produce modules that will fit into and play with the SPEAKeasy architecture. While originally conceived and designed for military applications to bridge the wireless gap among a diversity of tactical radio systems in use by the different services, SPEAKeasy can also meet the diverse requirements of the global wireless industry. In addition to obvious civilian governmental emergency radio needs, the possibilities for business users to easily reconfigure and reprogram their wireless handsets to meet different local, national, and international standards presents an open network answer to the challenge of multiple cellular, PCS, and mobile satellite architectures and systems.

1 Introduction

There are many kinds of military radios, each developed for a special purpose and, very often, not interoperable with each other. This hinders cooperative operations, military or civilian, involving various forces and agencies, each equipped with its own peculiar radio. To solve this interoperability problem, the US DOD is developing the SPEAKeasy software-defined radio.

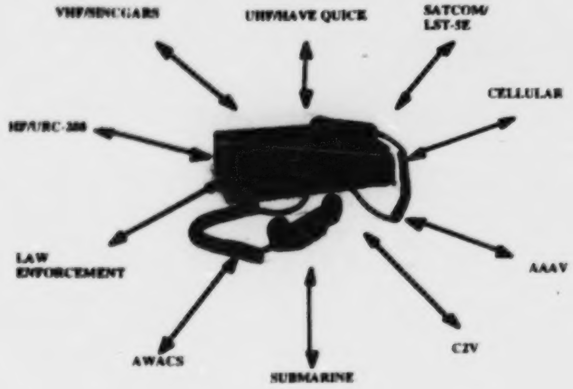

FIGURE 1
SPEAKEASY INTEROPERABILITY

Figure 1, SPEAKeasy Interoperability, lists some of the specialized two-way radios used by the military, police, emergency services, etc. SPEAKeasy will be capable of being reconfigured thus enabling commonality and flexibility previously unattainable. It will be built around an Open System Architecture, with many functional modules, connected via common bus and software programmable.

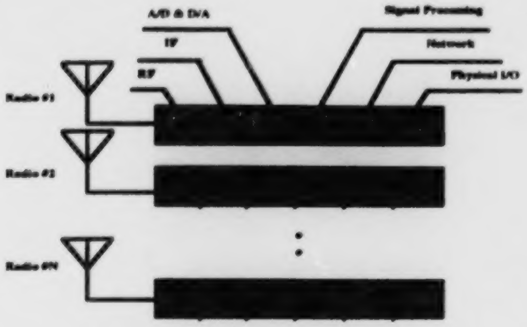

FIGURE 2 TRADITIONAL
RADIO BLOCK DIAGRAM

Most radios consists of these functional areas as shown in Figure 2, Traditional Radio Block Diagram.

The antenna, RF, and intermediate frequency sections are all analog. The IF signal may be digitized to produce a digital data stream that is processed by digital software. The digital processing may include signal processing, network functions, and physical input/output. To communicate with n different radios, you could simply pack n radios in a single case and call it a multiband, multimode radio.

A software programmable radio, as shown in Figure 3, Software Programmable Radio, works much like a personal computer — allowing the simultaneous operation of a number of transceiver "programs" to operate on a single hardware platform. This platform acts as a digital signal processor using software instructions that allow it to perform bandpass filtering, automatic gain control, frequency translation, and demodulation of the desired signal. Each waveform type has its own program stored in the radio's memory, which is loaded into the signal processor when it is needed. Most software programmable radios consist of the following basic building blocks:

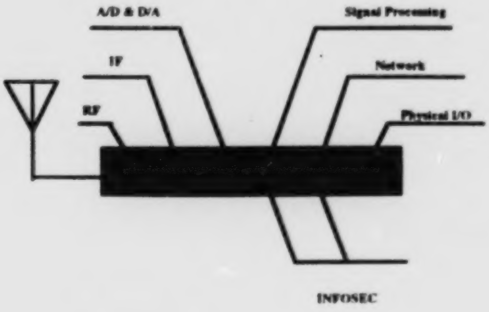

FIGURE 3 SOFTWARE
PROGRAMMABLE RADIO

-RF/IF: conditions analog input for the A/D converter; must be broadband enough with sufficient dynamic range to accommodate the software radio operational frequency bands and input levels

-A/D & D/A Converter: digitizes analog signals leaving the RF Front End; ideally, conversion is close to the antenna allowing for more digital signal processing to be accomplished

-Signal Processing: runs receiver waveform programs, performs channel selection, gain control, and selected frequency demodulation

-Network: may or may not be in radio, runs link and networking layer protocols handling interaction with other end radio and network

-Physical I/O: handles presentation of information to user

-INFOSEC: may or may not be in radio, provides encryption/decryption of information.

An open architecture, software programmable radio would have many benefits. The Open Architecture aspect of SPEAKeasy ensures that many components will be off-the-shelf and as the system becomes more accepted, several sources for individual components should emerge. This will result in a lower overall cost for the system for initial acquisition, as well as repair and product enhancement. Software programmability of SPEAKeasy will allow it to become interoperable with whatever radio it has software to emulate. This becomes advantageous when it is not practical or cost effective to have as many radios as would be needed to communicate on every desired waveform or system. An additional benefit is the ability to easily upgrade the system when the communications standards change or evolve. Another useful feature being designed into SPEAKeasy is the Bridging/Internetworking capability. This will allow the radio to be configured as a translator between voice or data systems.

SPEAKeasy will be interoperable with the US Army VHF frequency hopping SINgle Channel Ground Radio System (SINCGARS), US Air Force UHF frequency hopping HAVE QUICK radio, law enforcement radios, air traffic control systems, maritime radios, and many more. Of course, in its military configuration, with at most four independent channels, it will communicate with at most four different radios simultaneously. Besides communicating with the different radios, it will receive, voice or data, on one channel from a particular radio, and pass that on to another radio using another channel functioning as a bridge between radios. This bridging will allow various services and agencies to retain their current inventory of radios and still interoperate with others using different radios. Current inventory radios needing replacement could be replaced by the more capable SPEAKeasy radios, interoperating with the remaining legacy radios as well as other radios.

The IBM PC was designed to have an "open architecture." This "open architecture" has allowed manufacturers to produce PC clones drastically reducing the price. SPEAKeasy will develop an architecture, and publish pertinent interface specifications so that other manufacturers may build components. SPEAKeasy will have other similarities with the PC. It will be reprogrammable. In a PC, there are many application programs, i.e., word processing, spreadsheet, graphics programs, etc. A user activates and uses whatever program is needed at any time. Similarly, SPEAKeasy will have available many radio waveforms in software form, any one of which can be activated and used at any time.

SPEAKeasy will be programmable the same way that a PC is programmable, with software loaded from a floppy disk. It may also be loaded through the radio receiver, in a manner that is analogous to down-loading software into a PC from the Internet or over a modem. That is, the program could be sent or retrieved from a master SPEAKeasy radio and loaded on the target radio via an operating channel and stored in memory. This is called an over-the-air-distribution of waveforms.

Some existing radios are already "modular by function" as defined and developed by each individual manufacturer. What is different is that (most) existing radio modules are frequency, band, or waveform specific. This limits their inherent flexibility, growth, enhancement-potential, and interoperability with deployed radios having different missions. SPEAKeasy modules however, though similar in function, will be "generic" in frequency, band, and waveform. They will obtain their mission uniqueness from the software (or in some cases reconfigurable hardware such as Field Programmable Gate Arrays). This means that a "functional module," however it is defined, will be applicable to many diverse radio systems (from HF to UHF), to many military or commercial users (Army, Navy, Marines, PCS, cellular), and to many military or commercial platforms (Aircraft, Ships, Manpacks, automobiles, homes, etc.).

2 Phase 1 Program

The US Defense Advanced Research Projects Agency (DARPA), Air Force's Rome Laboratory, and Army's Communications Electronics Command (CECOM) joined together to develop this common software radio capability. A proof of concept, research and development program was awarded in 1990 to US Corporations Hazeltine Corporation, Greenlawn, NY, TRW, San Diego, CA, Lockheed-Martin, Nutley, NJ, Motorola, Scottsdale, AZ and Rockwell-Collins, Cedar Rapids, IA. The 6 ft tall prototypes had two programmable channels, used a VME bus architecture, incorporated a Texas Instrument quad-TMS320C40 multi-chip module for digital signal processing and employed a SUN Sparc 10 workstation as man-machine interface. Models were demonstrated at war games held at Hanscom Air Force Base, MA, in September 1995. Capabilities demonstrated were:

- Simultaneous operation two channels in any band (HF/VHF/UHF)
- Frequency hopping waveforms
- Waveform software down-load from floppies
- Voice bridging of all waveforms

3 Phase 2 Program

A contract for a second phase of development was awarded to Motorola, Scottsdale, AZ, ITT, Ft. Wayne, IN and Sanders, Nashua, NH in June 1995. This Phase is furthering the earlier work by refining the Open Systems Architecture, enhancing the RF design, and reducing the size. This phase will produce an architecture for a 6-channel (4 programmable, 1 GPS receive, 1 cellular phone) multiband, multimode, radio (see Figure 4, SPEAKeasy Phase 2 Architecture) resulting in 6 prototypes in late 1999. A build-and-test strategy will deliver prototypes with increasing capability in mid-'97, and in late '98. Units are expected to be approximately 0.4 cubic feet in size, weigh 30 pounds, draw no more than 60 watts and be capable of being ruggedized for use in most applications.

A contractual requirement is the publication of the specifications for the Open System Architecture radio, modular by function, with many of the modules common, composed of component building blocks/modules. "Open"—meaning that the interface specifications at the various layers and the various module boundaries will be published, to allow the builders to focus on modularity by function, rather than by radio. With interfaces widely published, modules can be improved and enhanced; with numerous vendors making improvements.

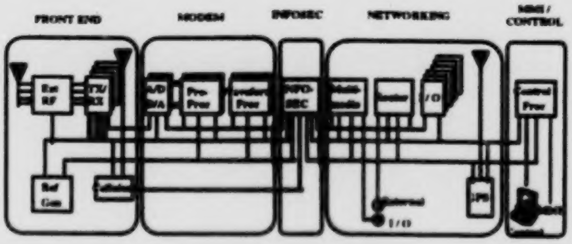

FIGURE 4 SPEAKEASY
PHASE 2 ARCHITECTURE

A Modular, Multifunction Information Transfer System (MMITS) Forum running concurrently with Phase 2, is providing industry feedback and insight into the design. In this manner, by the conclusion of Phase 2 in 1999, other radio manufacturers will be able to produce modules that will fit into and play with the SPEAKeasy architecture. These open system specifications, and the emphasis on the use of commercial off-the-shelf (COTS) hardware, will reduce the costs of acquiring the production version of the radio and lower overall logistics costs.

The MMITS Forum Vision is to assist in providing high quality, ubiquitous, competitively priced wireless networking systems equipment and services with advanced capabilities. This vision includes an expectation of seamlessness across diverse networks and integration of capabilities in an environment of multiple standards and solutions.

The mission of the Forum is to accelerate development, deployment, and use of software definable radio systems consistent with the vision objectives. The forum will work toward the adoption of an open architecture for advanced wireless systems that includes the requisite functionality in terminals, networks, and systems to provide "multiple capability and multiple mission" flexibility for voice, data, messaging, image, multimedia and future needs.

Forum members are establishing requirements related to the definition of internal and external system interfaces, modules, software, and functionality that the industry can use as guidelines in building modules, products and systems. Further, the Forum will promote the development of standards for MMITS, including those focused on MMITS and those in supporting service application.

interoperability and performance areas, and in underpinning core technologies, either directly or through appropriate liaison to other industry associations and standards bodies.

To assist the wireless and other industries in understanding the value and benefit of software defined radios and particularly the MMITS vision, the Forum is also addressing market requirements, quantifying the market, and developing timelines relative to the use of multi-mode, multi-band, and multi-application wireless communications systems.

MMITS Forum membership, currently more than 100 people from 74 organizations, includes telecommunications users, equipment suppliers, and developers of technology, products, systems, hardware, and software as well as service providers and system operators and any other individuals, organizations, or entities who have an interest in furthering the objective of MMITS (see Table 1, Partial MMITS Membership).

Samsung	Nokia	TADIRAN	Magnavox	Thomson-CSF
M/A-COM	Harris	Lucent	BBN	CIE
NORTEL	SW Bell	Aydin Vector	Northrup	US DoD
Honeywell	Ericsson	Raytheon	ITT	UK MoD
Lockheed	Rockwell	Hughes	Motorola	French Proc
Analog Devices	enVia	MITRE	Bell South	Orange Pers
Allied Signal	ARINC	BERG	TRW	GEC Marconi
Boeing	SRI	IAI	Gen Dynamics	Texas Instr

TABLE 1 PARTIAL MMITS MEMBERSHIP

Since ease of use, mobility, enhanced productivity, and support for lifestyle choices are all wanted by communications systems users, obtaining convergence among wireless and wired services such as educational, entertainment, and information services requires improved internetworking and interoperability. Consequently, even consumers of communications services, communications service providers, equipment suppliers and maintainers can benefit from an open architecture coupled with the software definable networking radio systems developments espoused within MMITS. This community of interest not only includes the general public, but also includes governments and their associated requirements for defense, law enforcement, and emergency services, including national security and emergency preparedness activities.

Software defined radios use adaptable software and flexible hardware platforms to address the problems that arise from the constant evolution and technical innovation in the wireless industry particularly as waveforms, modulation techniques, protocols, services, and standards change. A software defined radio in the MMITS context goes beyond the bounds of traditional radio implementations and extends from the radio terminal of the subscriber or user, through and beyond the network infrastructures and supporting sub-systems and systems. MMITS is a concept that spans numerous radio network technologies and services, such as cellular, PCS, mobile data, emergency services, messaging, paging, and military and government communications.

One goal of the Forum's standards-based effort is to reduce costs by increasing the demand for common modules such as RF modules. Another goal is to allow seamless technology upgrade paths, such as could be achieved by replacing a single or dual mode receiver card with a future software defined multimode card without having to replace the corresponding exciter, security or networking elements of the radio. For base stations, the upgrade path may be as simple as replacing an older lower dynamic range analog-to-digital converter card with a newer high dynamic range ADC card.

Two committees have been created to work towards specific aspects of the vision. The Marketing Committee is addressing commercial (e.g., PCS), law enforcement, civil aviation, and military requirements in order to establish potential subscriber applications and evaluate possible marketplace volume. Similarly, the Technical Committee is focusing on the issues of applications, architectures (coarse and fine scale reusable modules) and form factors from buses like PCI and VME to chip-scale interfaces.

These committees and several working groups are partitioning applications and architectures into clusters within which these issues can be resolved to the mutual benefit of all the participants. Through these activities, Forum members from the commercial and military sectors are now engaged in the process of creating standard profiles for plug-and-play multi-band, multi-mode, and software-defined radio architectures. One unified architecture with a small number of market-driven instantiations may emerge that can be applied by the forum members to reduce the number of radio units the military needs to interoperate, for example, or to expand markets in aviation, automotive, and PCS and to provide the "future-proof" infrastructures needed to cost-effectively meet the demands of the burgeoning mobile marketplace.

4 Commercial Applications

While SPEAKeasy is being developed for military applications, programmable radios can have widespread use in the commercial sector also. SPEAKeasy can also revolutionize communications infrastructure, standardizing radio equipments, and enabling commonality and flexibility never before attained, based upon its open systems architecture.

While the current developmental emphasis has been on military requirements and military waveforms, some analysis has been done examining other commercial waveforms that might be implemented in SPEAKeasy. Cellular telephone standards (AMPS, GSM, NMT, etc.), PCS (PCS 2000, TDMA, CDMA), Paging Systems, Mobile Satellite Telephony standards (current INMARSAT, as well as evolving TDMA, FDMA, CDMA, etc., standards), Direct Broadcast Satellite, Wireless Data and Mobile Radio standards have all been analyzed for potential inclusion in the SPEAKeasy software suite. Most of these waveforms will be able to be implemented through the inclusion of software.

Different radios will require varying numbers of "modules" depending on their communications requirements, the packaging limitations, the frequency, and the sophistication. Configurations could be tailored to the users channel requirements, and the environment (available power, altitude, sea spray, ruggedization, etc.). Radio terminal costs could be based upon the number of channels required, the waveform software purchased, and any other "special" requirements. Per channel costs for a SPEAKeasy radio system have been estimated by Motorola to be approximately $15K US dollars for ruggedized, military systems. In large quantities, with Open System market competition, and with less stringent environmental requirements, the cost is expected to be considerably smaller.

This kind of capability opens up the possibilities for a type of device that would be universally usable wherever a traveler might be for his cellular, PCS, Mobile Satellite Telephone and Wireless data needs. In passing from an area using one standard to another, the only thing that would need to be changed would be the radio software.

5 Summary

The SPEAKeasy software programmable radio presents an opportunity for Asian-Pacific business travelers to easily overcome the challenges of different wireless standards in different countries and regions through reprogramming their handset to meet local conditions. Moreover, the production of low cost, modular, and off-the-shelf components for this software defined equipment by established wireless manufacturers promises to rapidly lower the product's cost.

Another benefit for Asian-Pacific users is the rugged construction and few environmental restrictions of the systems. This is obviously a great advantage in a region where HVAC and electricity supplies vary enormously in areas as diverse as Japan, Malaysia, Indonesia, India, and Guam.

Finally, the security of transmission over individual systems within a corporation can be enhanced by insertion of a module with its own custom crytographic unit.

The SPEAKeasy software programmable radio, therefore, creates a strong potential for a seamless wireless communication network among its users in a region where wireless telecommunications is rapidly becoming the medium of choice for business.

In-house Education of Communication and Information Technologies at NEC Institute of Technology Education

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1. ABSTRACT

NEC Institute of Technology Education (*ITE*) is an in-house education organization of NEC. One of *ITE*'s objectives is to transfer internal technologies and to spread the most advanced technologies throughout the company. *ITE* has many study courses or themes related to communication and information technologies. These technology fields are areas where recent changes and advances are the most radical. *ITE* is trying to cope with the advances, providing the most comprehensive curricula. Several features of *ITE*'s operation are believed to be the keys to successful in-house education.

2. INTRODUCTION

NEC Institute of Technology Education (*ITE*) was established in 1979 by strong initiatives from top management as one of our corporate management strategies, because the education provided by Japanese universities and OJD (On the Job Development) could not give engineers all knowledge and abilities that they need to play an active role in the front-line of technology innovation.

One objectives of *ITE* is to transfer in-house technologies and to spread the most advanced technologies throughout the company in order to maintain and promote the superiority of the company's technologies. The other is to develop creative human resources.

The basic operating policies of the *ITE* are that the company should implement continuing education by itself, in the technology fields that will be most needed in the future, at the levels required and with content of importance, for willing and selected employees. Another policy is that the lecturers and advisers should mostly be in-house key persons who are familiar with the necessity for and the contents of the latest technology.

The results of a recent opinion survey in our company indicate that about 30% of the engineers who responded to the survey, have strong expectations for continuing technological education so that they will be able to grasp the most advanced technology. Therefore, the necessity for an in-house education is strongly endorsed by employees.

This paper introduces study programs at *ITE*, and describes in detail study courses or themes related to communication and information technologies. We are providing up-to-date content following the rapid changes in the technologies and business structures in these fields. Finally, we summarize the features for *ITE*, which are believed to be successful factors of in-house education and we point out further considerations concerned with in-house education.

2. OBJECTIVES AND STRUCTURES OF STUDY PROGRAMS

The needs of technological education have broadly been divided into three categories. One of these is for younger engineers to study, basically and systematically, the technology in the major business fields of the company. Another need is for leaders or employees to become leaders in grasping the most advanced technologies in specific fields. Another is to improve rapidly the practical skills directly concerned with the job. To cope with the above mention needs, the *ITE* has three study programs: *ITSP* (Integrated Technology Study Programs), *PTSP* (Principle Technology Study Programs) and *RTSP* (Relevant Technology Study Programs). Features of these study programs are summarized in Table 1.

Table 1 TECHONOLOGY STUDY PROGRAMS AT *ITE*

	ITSP	*PTSP*	*RTSP*
Regular number of students	50 persons/course	10 persons/theme	10-100 persons (Varying with course)
Prerequisites	After 2 or more years employment	After 5 or more years employment	From fresh men to supervisor
Academic ability	Equivalent to the level of university graduates	Basic knowledge in the appropriate technological field	–
Period	1 year	1 year	1 day-1 year (depend on courses)
Contents	6 courses Elective lectures in 4 courses 90 min. x 15 times x 8 lectures One full day a week (total 180 hr.) Lectures/Mutual study/Homework/Test/Tours	About 10 themes First half year : . 20 seminars A half day every two weeks (total 50 hr.) Second half year: Writing a thesis Seminars/Lodging study/Writing thesis /Thesis presentation	Lectures/Exercise/Test/ Lodging study/Tours/etc. (depend on courses)

2.1 *ITSP*

The *ITSP* is designed primarily for younger engineers who have rather limited technical capabilities in the field in which they are working, and is intended to widen these engineers' knowledge and capability in the major technical fields in the company. There are six courses in the *ITSP*: communication technology, computer technology, software technology, system technology, semiconductor device technology and mechatronics technology. The level of lecture is equivalent to that of master courses at Japanese universities. Each course has about 50 students who have ordinarily had two or more years of company experience and whose academic ability is equivalent to that of university graduates. The major parts of the program comprise a series of lectures arranged systematically for a duration of one year.

2.2 *PTSP*

The *PTSP* is designed for experienced engineers who require advanced technical skills, and it is expected to deepen the student's understanding of the most advanced specific technologies and to improve their specialties. The academic level of the *PTSP* is equivalent to that of doctor courses at Japanese universities. Every term, we choose about 10 themes from the most advanced technological areas, which are directly related to the company's business strategies.

Students are ordinarily required to have five or more years of company experience and basic knowledge in the appropriate technological field. Students must attend seminars in the first half of the one-year study period, and produce a thesis in the second half. Theses from the *PTSP* are distributed throughout the entire company, in order to disseminate information on the development of the most advanced technologies. Several theses have been accepted at major international conferences.

2.3 *RTSP*

The objectives of the *RTSP* is to make rapid improvements in practical knowledge and capability that are directly concerned with the student's own job. Courses are selected to meet common needs throughout the company. Currently, six courses are provided. The number of students and course period are dependent on the courses. Student levels vary from freshman to group leader.

2.4 STEERING COMMITTEE

The curricula, content and instructors for all the study programs mentioned above are proposed by a steering committee of the *ITE*. The committee is responsible for the development of the institute and creation of its strategies. Members of the committee are concurrently assigned to the position at *ITE* and are usually selected from general managers or chief engineers in the R&D, production and business divisions. This means that the operation of the *ITE* directly reflects business and technological development strategies.

2.5 LECTURERS

One important feature of the *ITE* is that we have no full-time lecturers. More than 90% of the lecturers belong to the company and are key persons in various divisions. Therefore, they can easily grasp the most recent developments and trends in advanced technologies and their impact on the business of the company. They are also familiar with the content that the students have to learn. Furthermore, by lectures from them, technologies and know-how in the company can be transferred from senior engineers to young engineers and between divisions.

ITE also invites outside experts, as lecturers, including university professors who were formerly with the company.

It is notable that there are more lecturers in *ITSP* and *PTSP* than students.

2.6 STUDENTS ATTENDANCE

ITE is located almost at the center of NEC plants scattered throughout the Kanto district (the capital area). In most cases, students are able to reach *ITE* by train in under one and half hours. Due to such convenience, students can engaged in half-day or full-day study in one or two-week intervals. Thus, for students, work and study are well compatible.

2.7 MUTUAL STUDY HOURS

The curriculum has opportunities called *Mutual Study Hours*, in which students are encouraged to participate actively in mutual study and discussion. On these occasions, the lecturer does not take part and students are divided into groups of about 10. They raise questions, try to answer these by themselves and discuss the study materials of the day.

3. STUDIES RELATED TO COMMUNICATION AND INFORMATION TECHNOLOGIES

Communication and information technology fields are areas where recent changes and advances are the most radical. *ITE* is trying to cope with the advances, providing the most comprehensive curricula in all the three technology study programs.

3.1 COURSES IN *ITSP*

The *ITSP* has four courses concerned with communication and information technologies, which are communication technology, computer technology, software technology and system technology courses.

The communication technology course has content which addresses the rapid evolution of technological convergence in the telecommunication area and the spread of telecommunication networking such as that on the internet and the intranet. One aims of this course is to allow students to study main communication technologies systematically ranging from basic theories to the most advanced technologies which are necessary for the construction of networks including switching, wire and wireless. Another aim of this course is to allow the students to study the application technologies of LSI and microprocessors for communication equipment.

In the computer technology course, students can learn advanced computer hardware technologies together with the computer architecture and software technology which are required in the age of the open-system, downsizing and multimedia, by studying the basic technologies of PCs, workstations, servers and other network components.

The software technology course has content which emphasizes middleware and applications, in answer to the remarkable changes in software technology. We have especially selected the internet, object oriented software, OLTP(On Line Transaction Processing), and network architecture, as subjects that software engineers in the front-line of development should understand.

In the system technology course, students study the advanced element technologies required for information system design, such as PCs (software/hardware), network architecture and multimedia. Also, students learn to understand the basic methodology for system construction and drafting proposals by case studies. System construction training is included in this course.

3.2 THEMES IN *PTSP*

In the *PTSP*, several themes, as listed in Table 2, are chosen from the most advanced technologies in communication and information technology fields. Recently, we provide more themes related to network and multimedia. In theme of *Multimedia Contents*, employees other than engineers are also included.

Information Society Theory Based on C&C Technology is introduced to investigate the information society as a post industrial society. The C&C technology, advocated by NEC since 1979[1)], is the information technology created

Table 2 THEMES RELATED TO COMMUNICATION AND INFORMATION TECHNOLOGIES IN *PTSP*

Themes related to network and multimedia
- Network Management and Control
- Information Network
- Security and Cryptosystem
- Encoding and Signal Processing for Multimedia
- Fault Tolerance Technology
- Multimedia Communication and Distribution
- Multimedia Application Technology
- Multimedia Contents

Special
- Information Society Theory Based on C&C Technology
- Low-Voltage and Low-Power Device Technology for Handy Multimedia
- CALS Technology

Others
- Digital Signal Processing and its Application
- Intelligent Information Processing
- Software Quality Technology
- Object-oriented Software Technology
- Large Scale Systems

by the integration of computers and communications. For this theme, staffs in planning divisions attend, together with engineers.

The purpose of ***Low-Voltage and Low-Power Device Technology for Handy Multimedia*** is to investigate low power LSI devices for handy multimedia equipment such as LCDs.

The ***CALS Technology*** theme is specially included to answer the needs required for the globalization of development and production.

3.3 COURSES IN *RTSP*

In the *RTSP*, the following four courses, namely ***Gate Array Design, LSI Design, VHDL, Production Design*** and ***Reliability Technology*** have been found fruitful in promoting the practical power directly related to jobs in communication and information technology fields.

Space Systems is a unique course for studying space navigation systems and satellite system construction.

4. CONCLUSION

After finishing our technology study programs employees become key-people in technology development and the business front-line. Every division in our company sends many engineers to our institute every year. In 1995, over 1,400 employees completed our programs. The total number of students as of 1996 reached approximately 1,7,300.

In conclusion, the features of *ITE*'s operation can be summarized, as follows. These are believed to be keys to successful in-house education.

The features of ITE

(1) Recognition of employee education by top management, as an important corporate management strategies
(2) Education programs and students reflecting technological strategies of the company
(3) *ITE* strategies implemented by steering committee members usually selected from general managers or chief engineers in the R&D, production and business divisions
(4) Continuing efforts to improve study programs to keep up with technological change
(5) Almost all lectures by in-house key persons in the front line
(6) Half-day or full-day study in one or two-week intervals
(7) Mutual growth by ***Mutual Study Hours***, without lecturer
(8) Forming human networks among students and instructors

Finally, we would like to pick up on some key factors which have to be taken into considerations for further development of our in-house education, as follows,

(1) Technological level of today's graduate
(2) Change in employee commitment
(3) Partnership between academics and industry
(4) Globalization of industrial activities

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NOTES:

Technology, Access, and Equity for the Pacific

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1. ABSTRACT

The United States Department of Education established the Regional Technology in Education Consortia (R*TEC) program in the fall of 1995 to help states, districts, schools, adult literacy centers, and other educational institutions use advanced technology to support improved teaching and student achievement.

The Pacific and Hawai'i activities are the responsibility of the Technology Collaborative for the Pacific under ARC Associates - Pacific Region, Inc. These R*TEC initiatives are part of the Pacific Southwest Regional Technology in Education Consortium (PSR*TEC), which also includes the states of Arizona, California, Colorado, New Mexico, Nevada, and Utah.

This paper focuses on the R*TEC basic goals and objectives to be addressed in the five years planned for the program's existence under the Office of Educational Research and Improvement. Included in the program activities during the first year in Hawai'i and the Pacific are the:

- Establishment of a technology demonstration site in a community center in Honolulu,
- Presentation of a technology summer institute for educators and local community leaders in Hawai'i,
- Working with the Pacific Regional Educational Laboratory (PREL) in the development of an educational technology leadership team
- Organization of technology workshops and institutes in Pohnpei and Guam and
- Development of collaborative strategic partnerships with local, regional and national groups.

2.0 BACKGROUND

2.1 K-12 EDUCATIONAL TECHNOLOGY NEEDS

The role of technology in society is growing annually. In 1993 a survey of 100 companies showed 30% already had some form of telecommuting in operation. [2] Schools need to anticipate the exit skills required of their students by the job market of the 1990's. [3]

In 1983 there were estimated to be fewer than 50,000 computers in schools across the country; by 1994 the number had increased to an estimated 5.5 million. Eighteen percent of schools had computers for instructional use in 1981. By 1994 that figure had reached ninety-eight %. In 1985 the median number of computers in grades K-6 was three; by 1989 that number increased to about 18, while in high schools the number increased from 16 to 39 in that same period of time. Despite the increase in numbers of computers there still remains relatively minimal weekly use of computers by students. [4]

Video is a related technology experiencing change in its form and format. Formerly instructional television was the primary mode of distance education. The Star Schools program now serves many schools with courses that would be hard for them to offer due to small school size, rural setting, or low demand for the subject. Commercial and non-profit services are also offering programming that is most often recorded by teachers on VCRs for later presentation to classes. CD-ROM and videodiscs are also rapidly-growing new modes of video technology found in schools.

Computer systems in schools should not only be viewed as structured learning environments but also as interactive learning extensions of the children themselves.[5]

Educational transformation will be successful by bringing together three agendas: an emerging consensus about learning and teaching, well-integrated uses of technology, and restructuring of school operations [6]

Keys to success in the use of technology will be the engaging of students in the learning process, the transformation of gathered information into new knowledge, and the changed role of teachers from being information providers to being facilitators of self-learning,[7] the development of experiential learning, and on the successful conveyance to students of the concept of lifelong learning.[8]

Success is encouraged by several factors: teachers are driving the movement; they are not required to use it in prescribed ways; students like using technology; parents are enthusiastic supporters; and teachers find increasing ways to utilize technology once they have overcome their initial reticence about using it. [9]

The future should show greater *integration*, *interaction*, and *intelligence* from technology applications. [10]

The Office of Technology Assessment 1995 study[11] projected by the spring of 1995:

- There would be 5.8 million computers,
- 41% classrooms have a TV,
- Only one in eight has a telephone,
- Less than 1% of teachers have voice mail,
- 75% of public schools have computer network links but only 35% have access to Internet,
- Only 3% of instructional classrooms in these schools have links to Internet,
- Many teachers make little or no use of computers for instructional purposes,
- Most teachers have not been trained in new technologies, and
- Most new teachers graduate from teacher preparation institutions with little preparation in how to apply technology to education.

2.2 REGIONAL TECHNOLOGY IN EDUCATION CONSORTIA PROGRAM (R*TEC)

In the fall of 1995 the U.S. Department of Education (through its Office of Educational Research and Improvement) launched a program to begin to address the aforementioned needs. OERI's authorizing legislation calls for a five-year program of research centers, regional laboratories, regional technology consortia, and ERIC clearinghouses to "reach beyond traditional definitions to a broader idea of educational research – an idea which includes every individual, regardless of age, gender, race, or creed, as the learner, and the world in which we live, beginning in the classroom and working outward, as the learning environment."[12] Key elements of R*TEC are professional development for teachers and other educators, technical assistance, and the dissemination of information and resources.

The country is divided into six consortia for program implementation. Each specializes in certain aspects of the R*TEC program. R*TECs are urged to work collaboratively with other technical assistance providers funded by the U.S. Department of Education such as the Comprehensive Regional Assistance Centers, the Eisenhower Regional Consortia for Mathematics and Science Education, and the Regional Educational Laboratories as well as other nationwide educational technology support efforts such as the Tech Corps.

2.2.1 PACIFIC SOUTHWEST REGIONAL TECHNOLOGY IN EDUCATION CONSORTIUM (PSR*TEC)

The PSR*TEC includes American Samoa, Arizona, California, Colorado, Commonwealth of the Northern Marianas Islands, Federated States of Micronesia, Guam, Hawai'i, New Mexico, Nevada, Republic of Marshall Islands, Republic of Palau, and Utah. The PSR*TEC lead agency is the Center for Language Minority Education and Research (CLMER) of the California State University at Long Beach.

Special program emphases include:

- Integration of technology to support high quality multilingual, multicultural education including special attention to technology integration which provides access for low-income and rural communities.
- Focusing on the community-wide nature of school reform and technology integration and access.
- Participation of diverse parents, community-based organizations, and community access networks.
- Providing 15 "empowerment communities" over the five year period with access to equipment and training to traditionally underserved students and families.
- Using multi-layered strategies for technology access and integration including development of sound technology integration plans.
- Developing teacher collaborative enquiry groups through mentoring and training.
- Working with colleges of education and working on technology solutions for administrators and principals.
- Working with parents and community members and state education agencies to foster local reform efforts and regional cooperation with a focus on diversity, equity, and access.[13]

2.2.2 TECHNOLOGY COLLABORATIVE FOR THE PACIFIC (TCP), ARC ASSOCIATES, INC.

The Hawai'i and Pacific island participants in R*TEC are the responsibility of Art, Research, and Curriculum Associates, Inc.(ARC) located in Oakland, California, and Honolulu, Hawai'i. ARC was established in 1977 to conduct projects funded by government agencies and by organizations in the public and private sector.. Since 1982 ARC has been publishing and disseminating curriculum materials developed by ARC staff for limited English proficient students.[14]

As part of ARC, the Technology Collaborative for the Pacific (TCP) is currently focusing on implementation of the PSR*TEC program objectives in Hawai'i and the Pacific islands within the PSR*TEC.

3.0 COLLABORATIVE VENTURES: YEAR ONE 1995-1996

3.1 PACIFIC REGIONAL EDUCATIONAL LABORATORY (PREL)

PREL assists education, government, community agencies, businesses, and labor groups to maintain cultural literacy and improve the quality of life by helping to strengthen educational programs and processes for children, youth, and adults.[15] PREL covers the same entities as the PSR*TEC so collaboration has been appropriate and effective. At the writing of this draft of the paper, cooperation has been underway with PREL in the areas of technology presentations at the Pacific Educational Conference and Guam Pacific Edtech Training Institute and establishment of the Edtech Leadership Team.

3.1.1 PACIFIC EDUCATIONAL CONFERENCE (PEC)

PEC is an annual conference sponsored by PREL for educators in the Pacific. This took place in Pohnpei in August of 1996 and brought together 1200 participants from throughout the PREL/R*TEC region. Participants came from all levels of Pacific schools and communities, and included State, District, and school administrators, classroom teachers, students, parents, and elected and government officials. Presentations on R*TEC, educational use of Internet and Star Schools were among the technology-related presentations. An Educational Technology Pre-Conference Institute was co-sponsored by PREL and R*TEC at the new College of Micronesia campus on Pohnpei.

3.1.2 PACIFIC EDTECH LEADERSHIP TEAM

In an attempt to develop enhanced use of educational technology throughout the PREL region the Pacific Edtech Leadership Team has been organized and consists of 2 members from each of the entities in the PREL/R*TEC region. These team members are classroom teachers, computer teachers, or school technology coordinators in their respective island communities. The team was organized for the following purposes:

- To learn to integrate technology into the curriculum and instruction
- To network and share integration skills with other educators throughout the Pacific
- To assist with needs assessment efforts in the region
- To explore and establish effective methods of communicating educational technology information to educators in the region
- To help plan entity-specific educational technology programs suitable to the priorities of the entities

The initial meeting of this group took place in Guam in September 1996, in conjunction with the Pacific Edtech Training Institute in which all team members participated. (See 3.1.3 for details on the Pacific Edtech Training Institute.) The initial Leadership Team meeting was enlightening and productive for all team members as common areas of need began to emerge from the start. These areas include Hardware and Networking Expertise, Software Evaluation Assistance, and perhaps most importantly, Teacher Training.

R*TEC is working closely to support the efforts of this group in its attempt to provide leadership for the educational technology development in the Pacific.

3.1.3 PACIFIC EDTECH TRAINING INSTITUTE

This one-week event was designed specifically for educators in the Pacific schools looking for assistance in using technology in the classroom and curriculum. It was planned as a way for educators to increase their technical skills, meet and share information with other educators, and learn about the process of integrating technology into the curriculum.

3.2 DEPARTMENT OF EDUCATION, STATE OF HAWAI'I (DOE) and HAWAI'I TECH CORPS (HTC)

The Hawai'i DOE has been a leader in development of statewide networking and teacher training. [16] In 1988-89 the Distance Learning-Technology (DL-T) program began as an effort to provide basic technology and telecommunications resources for all public schools in Hawai'i. In subsequent years there has been established the Office of Information & Telecommunications Services headed by an Assistant Superintendent that covers the programs of Advanced Technology Research, Information Resource Management Branch, Information System Services Branch, Network Support Services Branch, and Telecschool. These include the key technology applications of the DOE for administration and instruction. In recent years considerable progress has been made in providing Internet access through school networking projects in cooperation with cable TV companies and the Maui High Performance Computing Center. [17]

The Hawai'i Tech Corps is part of the national, non-profit organization of technology volunteers, funded by business community, helping to improve K-12 education at the grass roots, though the effective integration of technology into the learning environment. HTC has worked closely the with Department of Education in supporting DOE networking and technology enhancement needs. Initial leadership for HTC has come from the Maui High Performance Computing Center.

3.2.1 HAWAI'I SUMMER TECHNOLOGY INSTITUTE 1 (HSTI 1)

In July 1996 the three-day HSTI 1 was held in Honolulu. It provided a diverse group of Hawai'i educators and community members the chance to learn about new technology and begin to develop visions of ways high technology might help education in their respective areas. The institute was designed by the PSR*TEC staff in cooperation with ARC Associates - Pacific Region and provided professional development. It focused on ways to support constructivist, research-based multilingual and multicultural learning strategies for all students. Further technical support and workshop assistance was provided collaboratively by members of the Hawai'i DOE Advanced Technology Research division and Dole Intermediate School, a
blue-ribbon award-winning school, where the institute was held. In addition, the Hawai'i High Performance Computing Center staff provided resource personnel support.

3.2.2 HAWAI'I SUPER COMPUTING CHALLENGE (SCC)

SCC developed as a collaborative effort between the Hawai'i DOE and Maui High Performance Computing Center to help teams of students in Hawai'i schools. Each team was made up of 3-4 students, a teacher advisor, Hawai'i Tech Corps facilitator and community mentors. ARC – Pacific Region has provided consulting help and is serving as a mentor for schools participating in the 1996-97 SCC. Projects are focused on aspects of telecommunications development for local schools. Areas included are web page development, multi-cultural electronic field trips, and other types of technology development at the school level done in collaboration with community members.

3.3 KOKUA KALIHI VALLEY COMPREHENSIVE FAMILY SERVICES (KKVCFS)

KKV is a service unit that helps residents in the Kalihi Valley of Honolulu. They are interested in getting funding for community technology and career information projects.

3.3.1 KALIHI VALLEY HOMES COMMUNITY CENTER TECHNOLOGY DEMONSTRATION SITE

One of the KKV sites is the community center located in Kalihi Valley Homes. ARC Associates – Pacific Region was able to help KKV develop their model by loaning computers and related technology equipment in setting up a technology demonstration site at the center. Under R*TEC it plans to help in the implementation of the site with training and assistance in development of a community plan for technology access by residents of the community.

3.3.2 EMPOWERMENT COMMUNITY PROJECT

As part of the PSR*TEC goal of setting up 15 "empowerment community" projects in five year, the Kalihi Technology Demonstration site was identified as a potential candidate with support to be provided to enhance the current technology resources. Plans are underway to seek volunteers from the Hawai'i Tech Corps to help with technology networking and training needs in the coming year. Additional donation of telecommunications equipment was made the Hawai'i Career Kokua program.

3.4 HAWAI'I ASSOCIATION OF LANGUAGE TEACHERS (HALT)

HALT is the inclusive professional association for language teachers of all levels in Hawai'i. HALT became one of the early groups interested in developing a strategic partnership with R*TEC. They provided a good model when they used the Hawai'i Interactive Television System (HITS) to provide statewide remote participation by HALT members residing on the neighbor islands of Hawai'i, Maui, and Kauai during their spring 1996 annual meeting.

3.4.1 HALT FIRST LANGUAGE AND TECHNOLOGY STUDY GROUP

The first endeavor involved the collaboration with R*TEC in setting up a computer list-alias group of HALT members interested in exchanging information about first language programs and technology. ARC Associates – Pacific Region provided technical support to the group as they learned techniques with new technologies while exchanging information on first language issues.

3.4.2 LANGUAGE MAINTENANCE PROGRAM VIETNAMESE, CAMBODIAN, AND TAGALOG

As a result of the inspiration and enthusiasm of some HSTI 1 participants, Teleclass International [18] is sponsoring the establishment classes in Cambodian, Japanese, Tagalog, and Vietnamese. Plans are underway to establish a newsletter with information regarding the language maintenance program in the languages of interest.

3.4.3 MULTIMEDIA LANGUAGE EVALUATION PROJECT

A proposed project involving HALT members is that with the California Software Clearinghouse(CSC), a PSR*TEC consortium member. CSC has asked HALT members to help in the updating of their evaluation of multimedia language software programs. This would give HALT members a chance to see the latest in contemporary software as well as contributing to the CSC database of information now becoming available on the World Wide Web.

3.5 HAWAI'I SCIENCE TEACHERS ASSOCIATION (HaSTA) and NATIONAL SCIENCE TEACHERS ASSOCIATION (NSTA)

HaSTA became the first Hawai'i professional association to sign a strategic partnership with R*TEC in support of the program goals and any technology projects that could aid science educators.

3.5.1 HaSTA COMMUNICATION SYSTEM

The initial project with HaSTA was the establishment of a communication system that (1) let board members plan and coordinate by computer list-alias system and (2) set up a similar communication arrangement for all HaSTA members. In addition, periodic teleconferences involving neighbor island HaSTA members during board meetings and the spring 1996 annual meeting were organized. HaSTA is investigating following the HALT model using HITS for their spring 1997 annual meeting.

3.5.2 NSTA DISTRICT 16 COMMUNICATION SYSTEM

R*TEC has extended its collaboration to the District level of the National Science Teachers Association as a result of the NSTA District 16 leadership conference in Las Vegas December of 1995. The R*TEC support in setting up a list-alias permitted regional communication between NSTA members in California, Nevada, and Hawai'i. In the coming year it is possible the networking can be extended to the

Pacific islands, which are also part of NSTA District 16.

3.6 PAN PACIFIC EDUCATION AND COMMUNICATIONS EXPERIMENTS BY SATELLITE (PEACESAT)

In 1971 the University of Hawai'i Pan Pacific Education and Communications Experiments by Satellite (PEACESAT) program was founded as a government-funded, non-profit organization based on a proposal from the University of Hawai'i to use one of NASA's satellites for support of educational, community service, medical and environmental emergencies. [19] Over the years it has developed programming with more than 40 ground stations in the Pacific, U.S. mainland, and Asia. Attempts are underway to collaborate with PEACESAT in the starting periodical telecommunications with educators in the Pacific involved in the educational technology development in the Pacific island nations and territories.

4.0 FUTURE POTENTIALS: YEAR TWO 1996-1997

4.1 HAWAI'I TECHNOLOGY LEADERSHIP GROUP

It is hoped that the various R*TEC activities such as HSTI 1 and other collaborative efforts will lead to the establishment of a Hawai'i technology leadership group made up of representatives of traditionally underserved populations interested in the issues of access and equity in use of high technology resources. This group could additionally collaborate with existing technology development groups in Hawai'i to move forward the cause of high technology for all students K-12.

4.2 PREL PACIFIC EDTECH LEADERSHIP TEAM

This group is seen as providing a major potential for involvement of Pacific island residents in making a reality technology equity and access in their respective regions. Working toward this goal should be an important one supporting the core of R*TEC goals.

4.3 STRATEGIC PARTNERSHIPS MODEL PROGRAM

The experiences this year with establishing R*TEC strategic partnerships has been rewarding and an important and cost-effective way to encourage collaborative effort. In the coming year it is hoped the process can be extended to permit even broader collaboration as a result of strategic partnerships that reach regional and national levels.

5.0 CONCLUDING REMARKS

The Regional Technology in Education Consortium has ended its first year with several significant ventures in Hawai'i and the Pacific. It is hoped that this paper will provide further opportunities to reach out to others both needing the services of R*TEC but also those who can contribute to making it come closer to reality in the next few years as we move toward the 21st Century.

6.0 ENDNOTES

(1) See Sheingold, 1990
(2) See Morton, 1996
(3) See Papert, 1993
(4) See Means, 1993
(5) See Papert, 1993
(6) See Mehlinger, 1996
(7) See Smith, 1993
(8) See Morton, 1996; Resnick, M. 1996.
(9) See Morton, 1996.
(10) See Mehlinger, 1996
(11) See CLMER, 1965
(12) See OERI, 1996
(13) Ibid
(14) See ARC Associates
(15) See OERI, 1996
(16) See Bossert, 1995
(17) See MHPCC, 1995
(18) See Wollstein, 1986, Takeuchi, 1991 and Adamski, 1993
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Space Collaboration System Project in Japan

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1. ABSTRACT

This paper describes a new satellite network system among higher educational organizations in Japan, which is called a Space Collaboration System (SCS) project. This project started in October 2, 1996 with 50 VSAT (Very Small Aperture Terminal) earth stations placed at national universities and national institutes in Japan and a HUB earth station located at NIME (National Institute of Multimedia Education) using Japanese commercial communication satellite (JCSAT-3). VSAT stations were controlled by the HUB station with satellite channels. Therefore, in VSAT earth stations, no qualified staff is occupied to operate stations.

This satellite network enables the universities to make distance lectures, seminars, workshops and so on. All VSAT stations have completely the same number of channels, output power, the privilege of channel selection and so on. The SCS project is the biggest full two-way satellite educational network system in the world.

2. BACKGROUND

In Japan, higher educational system has been diversified dynamically during the last decade. Since information infrastructure has been developed very rapidly, distance education and learning at home have been expanded by using e-mail and TV conference system (1)-(3). For instance, many Japanese universities, which have reformed their curriculum to provide lifetime education for workers, housewives and retired persons, are making use of the new educational system.

Using Japanese experimental satellite ETS-V (Engineering Test Satellite-V), ISDN, Inter-net and optical fiber ATM network, the authors have many experiences of organizing distance education and joint classes for universities not only in Japan but also in foreign countries (4)-(6).

As a result, in the fall of 1995, the Ministry of Education appropriated an inter-university satellite communication network system in the budget, this network is called a Space Collaboration System (SCS) project. The network system consists of a HUB earth station at NIME (National Institute of Multimedia Education) and 50 VSAT (Very Small Aperture Terminal) earth stations at national universities, national college of technologies and national inter-university research institutions. The number of VSAT stations will be expanded to 62 at the end of Fiscal 1996 (i.e. March, 1997). Figure 1 shows positions of 62 VAST and HUB earth stations. Public and private universities are considering joining

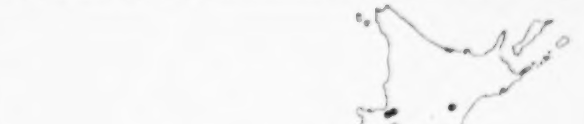

Fig. 1 Positions of Earth Station.

the SCS project in the near future.

The SCS project started to operate in Octorber 2, 1996.

This paper describes the SCS project which is the biggest full two-way satellite higher educational network system in the world. Using this satellite communication system, it becomes easier to learn and discuss on specialized and advanced topics at distance and multi- sites simultaneously.

3. FEATURES

3.1 CONCEPT OF SCS

Key words such as easy operation, flexible assignment and low cost are very important to establish the satellite network system at universities.

For easy operation; An operation of VSAT earth stations should be performed by participants or users themselves in universities with no specialist or qualified staffs. In Japan, radio regulation of VSAT earth station without qualified staffs is as follows.

- Transmission of VSAT earth stations can be controlled by the HUB station with control signals via satellite.
- Antenna gain is less than 50 dB.
- Output power of HPA is less than 10 W.
- Transmission rate of information is less than 3.3 Mbps.

For flexible assignment; It is insufficient to just connect from a limited site to others (i.e. broadcasting type). Therefore, VSAT earth stations of the SCS project can operate on full two-way communication among any site and any number of site at any time.

For low cost; it is necessary to investigate both an initial costs and running costs. A communication system, whose transmission rate is the same as ordinary TV system (about 30 Mbps), can communicate same quality on visual and audio. Thus, most of users rate the system high. However, it is necessary to pay the enormous initial cost (about a few million US $) and the huge change (about several thousand US $). Because the number of the SCS project will expand more than a few 100, we cannot establish the ordinary TV system (i.e. analog fullband system) as the inter-university network system.

As a results, the main features of the SCS project are as follows:

- Transmission rate is 1536 kbps (QPSK, FEC:1/2).
- Diameter of VSAT's antenna is 2.4 mφ.
- Ku-band (14/12 GHz).
- Output power of VSAT is 10 W.
- VSAT is controlled by HUB station.
- 2-channel/session is assigned.
- Proposal of use via Inter-net (homepage).
- Video coding is ITU-T H. 261.
- Audio coding is ITU-T G.722, SB-ADPCM.

As you know, there is a few picture coding standards such as H. 261, MPEG1, MPEG2, and so on. The H. 261 coding, the transmission rate of which is 64 *n kbps, has following advantages:

- H. 261 standard is already fixed.
- CODEC (esp. Encoder) is not expensive.
- Coding delay is small.

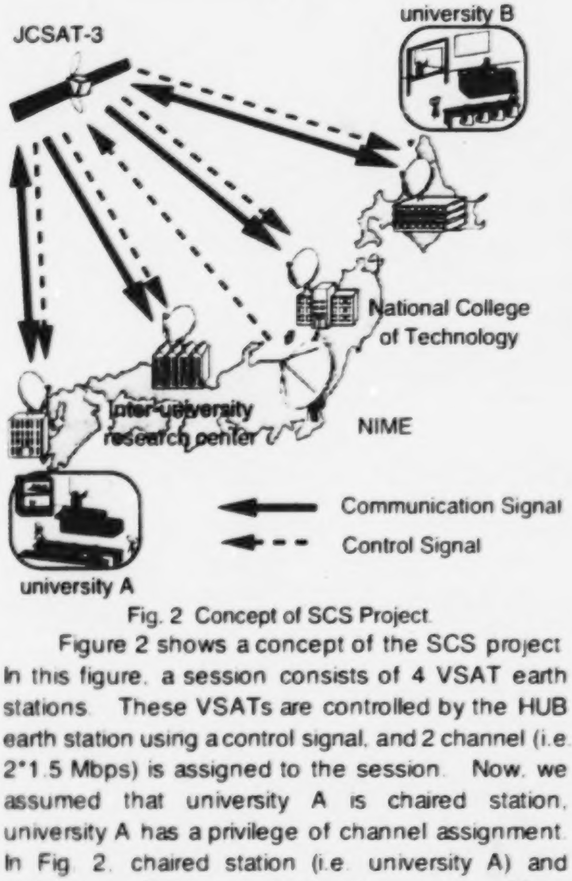

Fig. 2 Concept of SCS Project.

Figure 2 shows a concept of the SCS project. In this figure, a session consists of 4 VSAT earth stations. These VSATs are controlled by the HUB earth station using a control signal, and 2 channel (i.e. 2*1.5 Mbps) is assigned to the session. Now, we assumed that university A is chaired station, university A has a privilege of channel assignment. In Fig. 2, chaired station (i.e. university A) and university B are transmitting 1.5 Mbps communication signals, and inter-university research center (C) and national college of technology (D) are receiving these two communication signals. C and

D can demand to chaired station A that they want to send their messages to the session. Then, C and D are permitted to transmit instead of university B. Thus, these 4 VSAT stations can simply communicate each other.

3.2 VSAT STATION

Figure 3 shows a block diagram of the VSAT earth station. VSAT earth stations can send two channels and receive three channels, respectively.

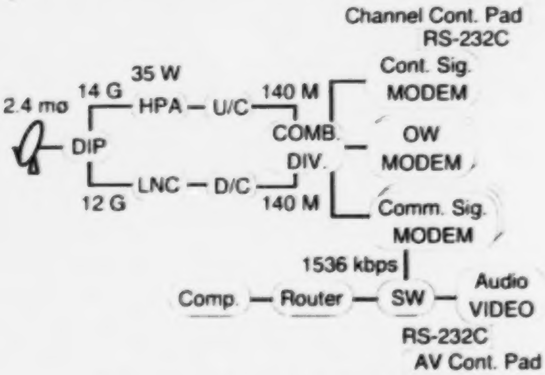
Channel Cont. Pad
RS-232C
Cont. Sig.
MODEM
35 W
14 G
HPA
U/C
140 M
2.4 mø
DIP
COMB.
DIV.
OW
MODEM
LNC
D/C
12 G
140 M
Comm. Sig.
MODEM
1536 kbps
Comp.
Router
SW
Audio
VIDEO
RS-232C
AV Cont. Pad

Fig. 3 Block Diagram of VSAT Station.

Table 1 shows an example of the link budget.

Table 1 Link Budget (VSAT-VSAT).

		Okinawa ->Tokyo	Tokyo ->Okinawa
VSAT Antenna Gain	dBi	48.7	48.7
VSAT EIRP	dBW	56.4	56.4
path loss	dB	207.3	207.3
abs. loss	dB	0.1	0.1
Ssatellite G/T	dBK	5.5	12.3
Satellite EIRP	dBW	30.3	29.3
path loss	dB	206.0	206.0
abs. loss	dB	0.1	0.1
VSAT Antenna Gain	dBi	47.9	47.9
VSAT G/T	dBK	23.7	23.7
Uplink C/N	dB	22.0	28.8
Downlink C/N	dB	15.4	14.4
C/IM	dB	16.0	16.0
C/I	dB	14.0	14.0
Total C/N+1	dB	10.0	9.9
Required C/N	dB□	8.0	8.0
Margin	dB	2.0	1.9

3.3 HUB STATION

Figure 4 shows a block diagram of the HUB earth station. For reliability of the network system, an each number of HPA, LNA, U/C and D/C is three. One of each components is for horizontal polarized wave, one is for vertical polarized wave and the other is for preparation. Therefore, if the HPA of horizontal polarized wave is damaged, the preliminary HPA takes the place of broken one immediately. Furthermore, the HUB station can compensate a rain attenuation by power control (PC) unit.

The HUB station can send six channels (four for horizontal polarized wave and two for vertical polarized wave) and receive fourteen channels (twelve + two), respectively.

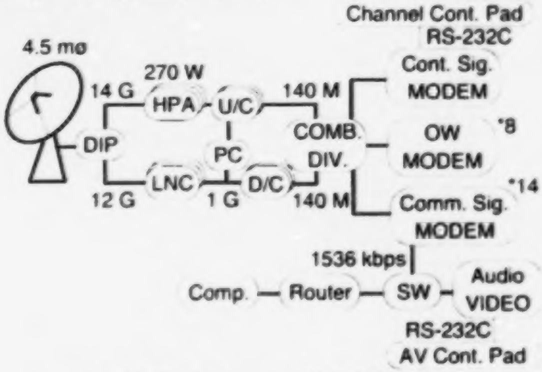
Channel Cont. Pad
RS-232C
Cont. Sig.
MODEM
4.5 mø
270 W
14 G
HPA
U/C
140 M
DIP
PC
COMB.
DIV.
OW
MODEM
*8
LNC
D/C
12 G
1 G
140 M
Comm. Sig.
MODEM
*14
1536 kbps
Comp.
Router
SW
Audio
VIDEO
RS-232C
AV Cont. Pad

Fig. 4 Block Diagram of HUB Station.

3.4 USAGE

After the opening ceremony which was held in October 2, 1996, there were/are many requests to reserve sessions from VSAT stations in order to make distance education, joint classes, joint seminars and so on. Table 2 shows a monthly usage of the SCS network.

Table 2 Monthly Usage

	No. of session	Hours
October, 1996	97	181:15
November, 1996	111	204:00
December, 1996	82	164:20
January, 1997	73	145:10
February, 1997	62	174:25
March, 1997	43	106:05
Total	468	975:05

(As of Nov. 25, 1996)

3.5 FUNCTION

Using the SCS network system, participants can not only communicate TV (video and audio) signals but also make local area networks each other.

Fig. 5 Outlook of JCSAT-3

Besides the domestic connections, the SCS project is performed by a Japanese commercial communication satellite JCSAT-3 as shown in Fig. 5. This satellite was launched in August 1995, and its footprints is as shown in Fig. 6 (7). Thus, using this satellite, the coverage of the SCS network will expand to Southeast Asia countries such as Thailand, Indonesia, Singapore and so on. This international project, which is called Post Pan-pacific Regional Telecommunications Network Experiments and Research by Satellite (Post PARTNERS), is collaborative project with Communications Research Laboratory, Ministry of Posts and Telecommunication (8).

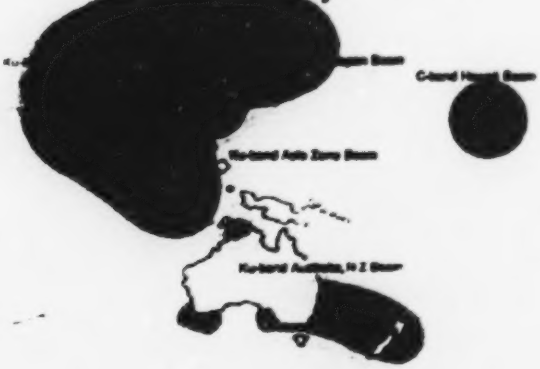

Fig. 6 Footprints of JCSAT-3

4. CONCLUSIONS

This paper describes a new satellite network system among national universities and higher educational institutess in Japan, which is called a Space Collaboration System project. This satellite network system consists of 50 VSAT and a HUB earth stations with JCSAT-3. VSAT stations were controlled by the HUB station with control signals via satellite channels. Therefore, in VSAT earth stations, no qualified staff is occupied to operate stations.

This satellite network enables the universities to make distance lectures, seminars, workshops. All VSAT stations have completely the same number of channels, output power, the privilege of channel selection and so on. Thus, the SCS project is the biggest full two-way satellite educational network system in the world.

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Moving Toward the 6th Generation of Distance Education

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1. ABSTRACT

Over the past several years there has been a lot of discussion on the next generation of the university educational system and the role distance education will play in this new paradigm of education. This paper will discuss this new paradigm as well as the sixth generation of distance education, referred to as virtual education throughout the paper. The first part of the paper will provide a summary of the previous five generations of distance education and lay the groundwork for the sixth generation. The discussion will be framed around the components of the traditional model of university education and focus on the benefits of each. Following the discussion of the virtual education model, there will be a brief discussion of the effectiveness of this paradigm.

As virtual education will also require many transformations from the existing educational model, there will also be a discussion of the technical, societal and organizational changes required to implement the new model. As these changes will need to be administered several recommendations relating to the political, business, economic and technical factors will be discussed and how they will aid in affecting this change.

2.0 INTRODUCTION

The past several years have brought on discussion about the next generation of distance education. The council of Western Governor's have outlined their thoughts on the matter in several public releases available on the world-wide web. But what are the origins of distance education, how has it developed, and what improvements will the next generation have over the current educational paradigm.

This paper will outline the characteristics of the current educational paradigm, provide a synopsis of the history and growth of distance education, provide the author's views on the 6th generation of distance education and then discuss the effectiveness of the paradigm.

3.0 CHARACTERISTICS OF TRADITIONAL UNIVERSITY EDUCATIONAL MODEL

The traditional educational paradigm of a university has been described as having the following characteristics (6):

- course development
- examination
- research library
- teaching methods
- andragogy
- mentoring
- curriculum
- tutoring
- course writing

4.0 DEVELOPMENT OF DISTANCE EDUCATION MODELS

In this next section the development of each distance education model will be elaborated upon. The relative merits of each model will be explained. Throughout this section the discussion of the networks and associated costs will be minimal.

4.1 PRINT-BASED DELIVERY

The first generation of distance education was the print-based delivery model and primarily used paper materials such as pamphlets, books and handouts to educate. Even today with all the advances in technology that exist, print is still the dominant form of instructional media.

4.1.1 ADVANTAGES TO PRINT-BASED DELIVERY

Print has been a dominant teaching tool since Gutenburg invented the printing press. The primary benefits of using print as a means of distance instruction is that it is reliable,cheap and very accessible. It is because of this accessibility that books and magazines are still in existence. Unlike electronic media, a print-based instructional item can be used at any location. Print requires no special equipment so it is inexpensive for the learner. Print can also be sent through the mail service, in many countries the mail system is very reliable and fast. Express couriers, like Federal Express, and United Parcel Service can also be used if the material needs to arrive faster than the local mail system could deliver.

Print is also very user-friendly in that it is very self sufficient. Print-based instruction can go anywhere, does not need electricity, can be taken to the beach, to the woods or on a trip to the mountains. Print has the added advantage that it is easy to scan quickly and derive the main thrust of the text.

4.1.2 DISADVANTAGES TO PRINT-BASED DELIVERY

Though print-based delivery of instruction has its advantages it also has many disadvantages. It has been shown that the student needs to have either a strong personal desire, or a strong economic desire (6). The student studying at a distance can also suffer from loneliness from lack of interaction with other peer groups and the principal instructor.

Feedback from the instructor is also slow in coming since it relies on the mail system to provide this mechanism. According to Borje Holmberg "The greatest weakness of distance education has in most cases been the slowness of the communication process caused by correspondence method dominating this type of education" (7). This delay caused by external forces could be a source of frustration for the student particularly if the student is having difficulty with a certain subject area. Courses are also extremely difficult to modify, inserting new material to keep it up to date or correcting an error after the material has gone to print could prove to be costly. Distance educators believe that printed instructional materials should be of very high quality because of the circumstances of the distance student. It cannot be assumed that these students will have as easy access to teachers as campus-based students would, nor can it be assumed that they will have access to a strong peer-group. They are much more isolated than the traditional student so they need to have well prepared comprehensive materials (2).

4.2 ONE-WAY BROADCAST

The 2nd generation of distance education is the one-way broadcast model. Generally the radio was used by many institutions to deliver audio-based instruction, however other technologies were also utilized. In the next section, the technologies utilized in delivering instruction over this medium will be discussed.

4.2.1 TECHNOLOGIES INVOLVED IN ONE-WAY BROADCAST MEDIUM

There are a variety of technologies involved in the one-way broadcast medium. For purposes of this study the one-way broadcast medium will refer to the technologies that are transmitted from the educational site. This means that the student can only receive the signals from the institution and cannot use the same media to simultaneously interact with the source.

The technologies would include an instructional television broadcast, a radio sideband, an audio-cassette and lastly a videocassette of a presentation, lecture or series.

4.2.2 ADVANTAGES OF ONE-WAY BROADCAST MEDIUM

In this section the advantages of each of the technologies associated with this method of distance education will be covered.

4.2.2.1 TELEVISION, VIDEOCASSETTE AND DISKS

There are many advantages to the one-way broadcast method of television. The first is access, television is at most work sites, schools and particularly in Western Countries in a majority of the homes. With this access there is also a potential for a large audience.

It has also been shown that television provides the following advantages:

- Improved learning efficiency:
- Personalized instruction:
- Student recruitment:

Another advantage, according to Tony Bates is that "Television is the richest medium, in that it can combine all the major forms of symbolic representation: words, pictures, movement, sound and 'real-time' representation of events" (2).

Television can also be used to demonstrate experiments. In a televised chemistry class the lab could be demonstrated to the student, this is something that could never be done with text alone.

Videocassettes and videodisks allow for time-shifting on the students part, if the class is recorded on either format it allows the student to watch the instruction at a convenient time, rather than being tied to a broadcast schedule. Both formats also have the advantage that they are very easy to distribute and can be duplicated quite easily.

4.2.2.2 RADIO AND AUDIO CASSETTES

Audio shares a lot of the advantages that video formats have; in cassette form they are very easy to reproduce and allow for time separation from the instructor.

Some other advantages are that the radio like the audio cassette, is a reliable medium, is easily accessible and can be updated easily to reflect curriculum updates.

4.2.3 DISADVANTAGES OF ONE-WAY BROADCAST MEDIUM

In this section the disadvantages of each of the technologies associated with the one-way broadcast method of distance education will be covered. The disadvantages section will not take into account the costs associated with the technology.

4.2.3.1 TELEVISION, VIDEOCASSETTE AND DISKS

Instructional broadcasts like those sent to work sites, schools and broadcast over cable to the home require the learner to be available at that time. When the learner is not able to be present, they may miss the lecture unless they are able to record the broadcast for viewing at a later date. Once the student falls behind they may not be able to complete the assignments in a timely fashion. This could cause them to do poorly, or lose interest in the course. Some other method needs to be employed to provide the necessary feedback.

4.2.3.2 RADIO/AUDIOCASSETTES

Some disadvantages are that radio, like most audio-based instruction, is not as effective a teaching tool when it is not used in combination with other delivery methods. Some institutions combined the radio or print model with audio-cassettes. Curriculum presented via this medium can be organized into sections with discussion topics and review. However audio-cassette delivery also suffers from a lack of interactive capability and provides little opportunity for the interchange of ideas.

4.3 TWO-WAY AUDIO BROADCASTING

The third generation of distance education was two-way audio broadcasting, this primarily was used as a means of helping the student feel connected to the organization, or to provide the student with an opportunity to ask the instructor or tutor for clarification on the instruction. The telephone is the primary audio approach used by distance educators.

4.3.1 TECHNOLOGY

The primary technology involved in this form of distance education is the phone. This would be either in the form of a party-to-party conversation or a conference call with many people.

4.3.2 ADVANTAGES OF TWO-WAY AUDIO BROADCASTING

The advantage that this method has is that it finally gives the student an opportunity to interact with the instructor immediately. This form of instruction is usually used along with other resources, usually a text book. Another advantage to this method is access, nearly everyone in the modern world has access to a phone, either at their house or work. A new use of the telephone in distance learning is the introduction of voice mail, which allows for the creation of an audio "bulletin board" for information exchange.

4.3.3 DISADVANTAGES OF TWO-WAY AUDIO BROADCASTING

The disadvantage to this medium is that it needs to heavily rely on other methods. A course where the only form of instruction is given over the phone would not be very effective. For example, in a physical chemistry class that was conducted entirely by two-way audio explaining the results of the just completed experiment would take a lot of effort on the instructor's part without some form of video or text to accompany the audio lecture. This type of media combined with a technology like integrated services digital, not widely available at this time, would allow for faxes to be sent to the class participants while the lecture was occurring. This would allow the discussion of more complex topics while still conducting the class via two-way audio broadcast.

4.4 TWO-WAY BROADCASTING WITH INTEGRATED MULTI-MEDIA

The 4th generation is the Telecommunications with integrated multimedia model. For the first time with a distance education media there can be visual interaction with the instructor as well as informative graphics being displayed.

4.4.1 TECHNOLOGIES OF BROADCASTING WITH INTEGRATED MULTI-MEDIA

The technologies that are used in this medium are varied. Since we need to transmit compressed video we will need an advanced video network. This could be a network based on Asynchronous Transfer Mode(ATM), or a broadband integrated services digital network (B-ISDN). The CODEC (coder-decoder) is also a necessary component as this is the device that compresses the video and audio for easier transmission (9). The amount of compression determines the quality of the video and audio on the receiving end.

Other technologies commonly used are the microcomputer, either an IBM PC/PC Compatible, or a Macintosh/Macintosh compatible computer to display graphics or text used during the presentation. CD-ROM/videodisks are also used for storing the graphics and sounds required for the class. A videocassette recorder is often used for the transmission of short video presentations.

Video cameras and other supporting technology are also required if a feed is being sent to local cable access channel.

4.4.2 ADVANTAGES OF TWO-WAY BROADCASTING WITH INTEGRATED MULTIMEDIA

Students participating in a course utilizing this technology are able to "feel" like they are part of the class. For the first time, the students can see the instructor during the class. This allows the students to feel as though they are actually in the class, and provides them with opportunities to build a relationship with the instructor. Participating in the medium also helps the student to establish a visual connection among the other participants. Since the students and instructor are able to see one another in real-time, they can utilize conversation and body language (e.g. facial expressions). This interaction increases the understanding among the participants and encourages a more personalized lesson (9).

The utilization of this technology also provides opportunities to include experts on subject matters to augment the instruction with real-world examples. This can really increase motivation especially if students can interact with the expert and ask questions that interest them.

Lastly some systems support some form of document sharing. This function facilitates collaboration and feedback. By having a group of students at different locations work on the same document, they form a bond that can increase the synergy within the group and help the class as a whole learn more. This type of real-time feedback also gets across more points of view than would be available at one education center or with an individual.

4.4.3 DISADVANTAGES OF TWO-WAY BROADCASTING WITH INTEGRATED MULTI-MEDIA

Compressed video behaves differently than the traditional video most of us are accustomed to. In general, compressed video is broadcasting through a much smaller 'pipe' than traditional broadcast television does. The coding and decoding process takes a toll on the transmitted audio and video, this results in the following problems:

- Reduced frame-rate causing rapid motions appear to be jerky or "ghost-like".
- Reduced resolution causing the image to fuzzy or "soft" (9).
- Audio delays that can make participants feel uneasy (9).

This could result in people "stepping" on each others conversation as neither is sure if the other has finished talking. This is something that definitely would not occur in a face to face discussion (9). Since the type of technology used is not available to students at their home, the student is still required to travel to a centralized site to "attend" class.

4.5 COMPUTER MEDIATED COMMUNICATION

Computer Mediated Communication or CMC is the 5th generation of distance education. Gerald Santoro from Pennsylvania State University defined computer mediated communication as "the large set of functions in which computers are used to support human communication" (10). The main focus of CMC is on the use of computer systems and networks for the transfer, storage and retrieval of information, and to support human to human communication. In this case the computer is primarily a mediator, rather than a processor (10).

4.5.1 ADVANTAGES OF CMC

With the increase in use of the national networks, there has been a number of online databases made available at a low cost or free. For the last few years online journals have also become more popular. More and more paper-based journals and magazines are also placing an electronic version on the web. Many of these on-line journals also provide a way to search their back issues. This creates a database of information on a variety of topics.

With CMC not only can the class be enriched by the instructor providing reading and other research materials on a local server, but it also can be a significant time savings as they will not need to commute to campus to pick up a handout or reading assignment. With the advent of CMC and the amount of resources that are publicly available, learning can continue to occur for a student outside of the classroom. The eager student could do searches on a variety of topics using one of the many available web search engines.

Depending on the structure of the class, information sharing could occur, that is instead of the instructor standing in front of the class lecturing, or conducting the entire on-line conference, assignments could be given to a group of students to research a particular topic. The students could then be assigned to give a short presentation on their assigned topic. Then the instructor becomes a guide.

One major benefit is the time, space and distance barriers that usually exist between an instructor and student are eliminated potentially increasing the interaction between student and instructor.

4.5.2 DISADVANTAGES OF CMC

Of course the advantages of CMC outweigh the disadvantages, but there are several to consider.

For many students CMC is the first time they are exposed to email, and other activities related to it. All this exposure to new technology requires extra training for students. The instructor must take this into consideration when designing the course and plan appropriately for it. Learning the technology can also be frustrating for someone that has not seen it before so extra care needs to be given to these students to help them be successful in acquiring the new technologies. The instructor must also plan for the varying skill levels among the students provide something for the more advanced students to do. Lastly institutions will be required to provide access to advanced networks and will need to continually improve the hardware and software. This could create a support problem on the institution, they may not have enough trained personnel to maintain and repair all the equipment.

5.0 VIRTUAL EDUCATION

The 6th generation is the Virtual Reality model of distance education or virtual education. This model will use computers and multimedia extensively for course delivery. The difference is this model will also need to employ artificial intelligence to guide the learner, and provide information as the learner pursues different avenues of thought. Access to remote databases will be a must. The previous five models allowed for instruction removed from time-constraints and occasionally distance constraints but typically the interaction with the instructor was lost. The virtual reality model of education will allow the learner to be completely separated from time and distance constraints with the instructor being simulated by the artificial intelligence built into the learning system. Virtual education will provide a mean for humans to visualize, manipulate and interact with computers and extremely complex data. The view may consist of viewing into a database, a scientific simulation or a CAD model. The next section will cover the technologies necessary to implement virtual education and how it can be used to provide a new form of education. The technologies that will not be covered are the networks necessary to make all this happen but the reader should understand that there will need to be seemingly unlimited bandwidth available for this form of education to be successful.

5.1 TECHNOLOGIES OF VIRTUAL EDUCATION

There are many technologies related to virtual education, some of them are in their early formative periods now while others are still in the laboratory or in the far reaches of someone's mind. In this section the technologies are broken down into two areas; software and hardware.

5.1.1 SOFTWARE

The software that is around today is of course only the beginning of what we will need to make virtual education a reality. Some of the software tools that are around today are the likely ascendants to the next generation. These tools are:

Virtual reality modeling language (VRML) currently acts as a component within the web but in the future when the version 2.0 specification is decided on the features available to the developers will be further enhanced enabling the interconnection of virtual worlds (3).

For programming languages there will be several Java like languages that are architecturally neutral that allow the creation of network aware applets[1] (11). These applets will be able to interface with the virtual worlds that are created. As these applets are small, yet highly functional they would be perfect for this task.

We will also see moo and the web being combined to make a multi-media moo, and or a VRMud. This new functionality will combine the interactivity of text with the media rich content of the web. People will be able to hold a text discussion and be able to see the virtual world that they are collaborating in building.

The biggest thing to realize about the software is that everything will be modular and object oriented so pieces of different parts of software will be able to be linked together to create new software.

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[1] applet: a small one function application.

5.1.2 HARDWARE

The hardware possibilities are even more interesting. One of the first hardware innovations that is expected would be book viewers. These would be 8.5" X 11" screens with chips inside, and an ability to link up to the publisher's databases to download books, get the latest stock quotes, pull down the weather forecast from the weather computers, request a movie or attend a board meeting. The abilities of the machine would only be limited by the user of the device, what services were being paid for and the desires of the individual.

For this to happen there would need to be very good image generators, these machines would need to be able to replicate an image to the last detail to give the human eyes the impression that the object is really there. There would also need to be some manipulation and control devices (Joystick, handglove) that could be used to move objects around in this virtual environment. This could also be accomplished by utilizing position trackers, either ultrasonic, magnetic, optical or through the use of coordinate tracking (the computer would know the location of everything in the room at any moment in time, including the human participants). Using one of the methods the computer could "move" an object when something interacted upon it. This would give the interactor the impression that they had actually moved something. However the tactile senses would still not be fooled so there would need to be some kind of feedback mechanism to tell the interactor that they had touched something.

5.1.3 ADVANTAGES OF VIRTUAL EDUCATION

One of the first advantages that virtual education will have over the other forms of distance education is that objects will behave based on time and events. In the past objects that moved too quickly needed to be slowed down which tended to make the eyes tired. With virtual reality there will be haptic[2] rendering. This will provide the virtual reality citizen with a more lifelike experience.

With the immersive experiences of virtual reality, students will be able to learn from their own experiences (12). Instead of spending an entire semester explaining how the elements interrelate with one another, a virtual model could be setup. The students could then walk through the model and interact with it, they could take atoms and build elements, or they could simulate a chemical reaction and see how the reaction takes place rather than just seeing the results of an action that has taken place.

The students would be able to learn about physics and architecture by taking part in building virtual worlds. In these worlds the students could run a variety of simulations to see how the things in their world behave. For example to test a building's worthiness they could simulate natural disasters like earthquakes and tsunamis to see what would happen. This would be better than hundreds of hours of lecture trying to mathematically or anecdotally explaining what would happen.

One of the best advantages will be the ability to have a face to face consultation with your dentist, doctor, manager, client, or have team/group meetings without having to be physically in one location. It can be thought of as a virtual IRC, the participants can request to be part of a certain "reality" and will be linked to that conference. Collaboration on joint projects will become easier, instead of flying for hours to get to a location, just wake up, create your persona and join the conference.

5.1.4 DISADVANTAGES OF VIRTUAL EDUCATION

There are of course disadvantages to any technological innovation, this is no exception. The concern that we should have is in the implementation of this technology. Is it being implemented because of what it can do, or is the implementation being driven by the needs of society (10). If the needs are not taken into consideration, the technology may be wasted, not put into good use or may create even deeper divisions in our society of "haves" and "have nots". We also need to resist the temptation to make all students learn by computerized methods. We need to recognize the needs of each learner, for example, would we want to train young children via these methods or would we want them to learn with other children without any "special" interfaces and slowly throughout the early years of education introduce them to the technology (10).

Another disadvantage is that this virtual technology how ever it is used can be addictive. We can see today at our colleges and universities that some students when exposed to the Internet and its information and social tools spend far too much time on-line to the detriment of the other parts of their lives (4).

5.2 COMPARISON TO TRADITIONAL EDUCATION

Virtual education has the potential to be better than traditional education. It provides a better hands-on experience and allows the student to focus on things they never could before. Of course everything will need to change, since the instructor is not the "keeper of knowledge" any more, different examination and assessment methods will need to be established. Course writing will also be a thing of the past, rather perhaps the instructor will just identify resources that are out there and guide the students along the path of discovery. This means that teaching methods will also need to be changed. The instructor instead of being the presenter of knowledge becomes a guide along the learning path of the student. The student has access to mentoring and tutoring functions either through a designated peer or instructor advisor, or via a computerized advisor that can suggest multiple paths and provide the learner with a sampling of each course. Curriculums will also need to be revised, there may be fewer divisions within the university as more and more programs become interdisciplinary as a result of the technology.

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[2] haptic rendering: the sense of touch and force feedback.

5.3 RESEARCH ON VIRTUAL EDUCATION

As has been described above there is no research on virtual education outside of laboratories. But there is research on some early phases of virtual education will be covered in this section.

Starr Roxanne Hiltz, a professor at the New Jersey Institute of Technology conducted research on her idea of the "Virtual Classroom". The Virtual Classroom (registered trademark) is "a system for learning and communicating via connected computers. Students in the Virtual Classroom share their thoughts, questions and reactions with professors and classmates" (7). Her research conducted in conjunction with Robert Meinke of Upsala College, focused on examining "various types of courses, students and implementation environments" (7). By examining the deliverables for the class (exams, assignments, etc.) they would determine whether the virtual classroom was as viable for instruction as the traditional teaching methodology. They also had two major hypotheses:

H1: There will be no significant differences in scores measuring mastery of material taught in the virtual and the traditional classroom (TC).

H2: Virtual Classroom (VC) students will perceive the VC to be superior to the traditional classroom.

The results of the study confirmed the two hypotheses. The students with the exception of the introductory computer science students did no better in the TC versus the VC. Hypothesis two was also confirmed the students enjoyed the greater access to the instructors, enjoyed the increased participation in the course and especially liked the convenient access to the educational experiences.

5.4 SITES USING VIRTUAL EDUCATION

At the Indiana University's Center for Excellence in Education the focus is on envisioning the classroom of the future, including "virtual textbooks", clipboard sized computers with built-in lessons and reference materials and sensoriums which will use virtual reality technology to mimic experiences for study. (5).

Clemson University has several pieces of software that they developed to aid in the creation of virtual worlds, one is the hypershow a virtual reality environment rendering tool. The software can create architectural models with 6 dimensions of rotation. Another product, Radiate, is used to create the realistic lighting necessary for the models (14). Also at Clemson University, the Biomedical Engineering department will utilize computers to enable the students to perform test surgery and by using stereolithography to make prototypes of joints. Projects in the Architecture department include creating a virtual reality model of the campus.

Another example of a university making the move to virtual education is California Polytechnic State University (CalPoly), San Luis Obispo.

In 1992 CalPoly began two-way instructional video course offerings to its satellite campuses. Several years later they have begun the movement toward utilizing the megaserver concept. The classrooms have been equipped with high-resolution projectors, quality audio systems, and microcomputers with high-speed network access to the network servers and the Mega-server. Some indicators that the plan is working are:

- Network serves 2400 student residents, 1200 faculty and 900 staff.
- More than 13,000 of Cal Poly's 15,000 students have email access.
- More than one-third of the Fall 1994 admission applications were submitted in electronic form.
- Online administrative systems provide timely access to student records, class schedules, financial aid, grades and other information (1).

5.5 HOW SITES COULD USE VIRTUAL EDUCATION

In the last section we discussed how sites are using virtual reality to create new educational opportunities. In this section the discussion will focus on what services the university can offer as virtual education and virtual reality hardware and software become more mature.

The first is greater access to online databases of movies, texts, books, and other resources. The library will play a big role in the digitization of the campus and will be the means of training the students on how to utilize the technology for their coursework. The library may also be the keeper and maintainer of these substantial databases. These databases would be useful in creating lifelike immersion experiences for the students. Just imagine a Japanese language class roaming the streets of Kyoto, getting a feel for old Japan, reading the signs around them to serve as reinforcement for the kanji instruction. Meeting and conversing with native Japanese to really learn about the culture. These experiences would enhance the learning process and help the students to gain more out of the learning experience.

With the introduction of virtual technology into the education paradigm schools could be entirely electronic. One professor could work for several universities as an expert consultant for some classes and as an instructor for his/her home university. The university could also hire individuals in multiple countries to enable 24-hour instruction. This would better meet the needs of all the students, as some individuals that would like to advance their education work while the university is open. The university could also use this teaching pool as consultants. To provide tutoring for the students, the university could publish a list of instructors and their expertise, the student could then contact the faculty member and get their help. The university computers would keep track of the call, and pay the professor for the consultation immediately. The virtual education technology would also create an opportunity for the university to offer just in time training in the workplace. When a company wanted to send an employee to training they could contact the university and arrange a class. The university would then lookup in its database of "experts" and offer it to the available faculty member. This faculty member could then, if he/she accepted the "contract", develop a course especially for that corporation. The universities could also utilize this technology to capture lectures for later viewing by students. Eventually when the campus builds up a significant database on a particular area the database can be sold to another university for a nominal cost to help build their database, or it could be sold/given to a central repository. Once these database are built up it will serve as a source for the creation of multimedia or holographic presentations. The university could also get into specialized training, offer certificates in a particular field or subject matter, this would be in line with the reality that most professions will be requiring lifelong learning and upgrading of skills from its employees.

Of course the networks and applications could be used for more mundane purposes, the student could take a virtual tour of a campus to determine if they wanted to go to school there. After taking the tour, an application could be filled out and submitted for approval. Of course the approval process would be a lot faster as the student's transcripts could be pulled directly from their previous institution. If an interview were required or requested they could also take place at the same time.

5.6 EFFECTIVENESS OF VIRTUAL EDUCATION

There are many ways to measure whether virtual education is effective or not. Much of this effectiveness will depend on the following criteria:

1. Is the student proficient is his application of the subject matter?
2. Is the student employable?
3. Does this paradigm lend itself to life-long learning?

A student's proficiency is something that can be measured by assigning a task that requires the student to demonstrate their ability to solve a problem applying the techniques learned. If the student can successfully solve the problem then the virtual education paradigm is effective.

A students employability is a very important consideration. If the student spends years attending a virtual university and upon completion the student cannot find a job then the effectiveness of the paradigm is in question. This will unfortunately take time as it cannot be tested until the first student graduates and is hired. Employers will be taking a risk hiring an individual unless there is some way to ensure the graduate is competent.

The last consideration is the ability of virtual education to enable individuals to continue learning throughout there lifetimes. If the paradigm cannot adjust to the learners needs rapidly enough then the learner will continue to use the traditional forms of education to retrain. The virtual education paradigm will need time to prove itself but eventually it will prove itself more effective than the current educational paradigms.

6.0 ADMINISTERING TRANSFORMATION

To make the jump from distance education to virtual education several problems will need to be resolved. The first of which is the current educational system. Professors like the system the way it is, they know how to operate in the current environment. With virtual education professors will need to change from being the knowledge disseminators to being knowledge guides. They will still be creators of knowledge and will still have opportunities to impart this knowledge but will need to also react more to the individual students learning needs.

6.1 POLITICAL CONCERNS

Currently the political environment on campus does not encourage this type of transformation. At many campuses across the country the workload of professors are under scrutiny. This creates an environment of distrust and low morale. Professors are always being asked to give more and more and get less and less appreciation from the communities they are part of as well as their own administrative leaders. This will need to change if this type of educational transformation is to occur. Professors need to be given assurances that this will not place them out in the street and that they will be given more autonomy to conduct the necessary research to continually improve the educational experience for the consumer.

6.2 BUSINESS CONCERNS

The business community also needs to rally its support behind the professors and demand that they are allowed to provide the types of instruction necessary to provide students with pertinent skills that will help them to be gainfully employed. This could mean taking an interdisciplinary approach to create "generalists" that can be further trained on the job rather than a person that is so focused they cannot be utilized in other areas.

6.3 ECONOMIC CONCERNS

Economic concerns may be a catalyst of the transformation, the costs of maintaining a campus continually rise. As the educational needs of the general public grow this could mean building more buildings which require more money to maintain and require more support personnel. The other solution to this is utilizing virtual education paradigms. Rather than continually expanding the facilities, move some of the programs to this educational paradigm. It would allow more students to participate without having to add more classroom space. The increased revenues could be then used to maintain the communication architecture necessary to have a successful program.

6.4 TECHNOLOGICAL CONCERNS

To achieve the goal of virtual education communication technology needs to greatly improve. Some of the improvements may be achieved as the telephone, cellular and cable companies begin to offer similar services. The increased competition may provide the infrastructure necessary to implement some of the services. We can already see the predecessor to this type of competition as MCI and AT&T offer internet services and Time Warner's Oceanic cable offers an 10 megabit ethernet connection over coaxial cable. Many more technological changes will also need to occur before this new model of education can be brought about. Though it will take many years for the entire architecture to be in place it will not be shortcomings with the technology that will prevent this sixth generation of distance education to occur.

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Reinventing Education Through Information Technology

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1. ABSTRACT

Virginia Commonwealth University (VCU) is positioned to fully utilize information technology as a revolutionary tool for enhancing the scholarly environment for its faculty, students, and staff. The University will redirect existing resources and form strategic partnerships with both the private sector and other universities committed to change. IBM's Lotus Notes and Digital Library, and ATM technology will be the tie that binds and integrates the various desktop technologies at VCU with the surrounding community, the Commonwealth of Virginia and the World.

MOTIVATION FOR CHANGE

The impetus for change stems from three factors. First, higher education is being subjected to the same demands for greater efficiency and productivity that have caused major restructuring in other sectors of society. Secondly, there is increased scrutiny from both funding agencies and its customers to deliver a higher quality, more relevant product while meeting the needs of a student population much different than a decade ago. Thirdly, higher education is assumed to be a key player in applying the benefits of the 'information age' to society.

Cost: Virginia's public colleges and universities will be expected to absorb an additional 80,000 students by the year 2004 with reduced state funding. In addition, universities will not be allowed to make up the funding difference by increasing tuition and fees. Federal research funding, which has helped offset institutional expenses in the past, is less plentiful. The changing health care environment will decrease another source of funds that historically has supported the educational mission of the university. Only fundamental change will produce the needed efficiencies.

Quality: Universities and colleges are being evaluated against a different set of standards than in the past. The emphasis is on outcome: Higher education is judged by what students have 'learned,' not what they have been 'taught.' In fact, the central theme in the *Criteria for Accreditation* for the Southern Association of Colleges and Schools (SACS) is to evaluate an institution on its effectiveness in meeting its mission - effectiveness in educating students. VCU received the highest possible rating when it received its reaccreditation from SACS in 1995.

Demographics: The demographics of college students reflects the multicultural profile of the nation. In addition, today's students are commonly working adults who repeatedly enter and leave the higher education system over an extended period of time. These students typically are 'placebound' due to family and work requirements; consequently, time and location of instruction are very important to them. VCU students have different levels of exposure to and expertise with information technology. Each year, VCU's entering freshman class, like that of other universities, is increasingly 'at ease' with educational uses of technology. However, about two-thirds of VCU's baccalaureate graduates transfer to VCU from other institutions, including Virginia's community colleges. These students are not typical; they are older, often attend school part-time, are constrained by family and work responsibilities, and often are forced to interrupt their studies to fulfill other obligations. While this latter group may not be as experienced with computing as the typical freshman, they may benefit the most from the application of technologies that support 'time and place independent' delivery of 'personalized' instruction.

Opportunity: There is also good news. Many leading universities are beginning to meet the above challenges by leveraging the effectiveness of their faculty through the use of educational technology. The result is a more self-directed educational environment for the student and more time for individual faculty-student interaction. VCU already incorporates information technology as the primary vehicle for instructional delivery in programs such as cooperative Graduate Engineering and the Executive Master's Program in Health Administration. Effective use of these technologies allows institutions to extend their markets on a national or international basis and enables them to effectively compete in the current $100 billion per year training industry. The training market is expected to grow to $500 billion per year by 2005.

Education in the future will support both synchronous and asynchronous interaction between the learner and the sources of knowledge and information. Real-time, simultaneous two-way video presentations, multimedia presentations, and "education on demand" can be delivered to students on the campus, in their homes or their work places. Connectivity to the Internet and World Wide Web allows students and faculty to access educational resources. Escalating costs, declining financial support, increasing demand, and diverse demographics have placed significant pressures on higher education to become more productive. The focus for productivity improvement must be on learning.

It is this realization that is leading to a paradigm shift where students gain access to information resources, faculty lectures and demonstrations, conferencing and tutorials over networks from digital information organized by the faculty. The productivity gains occur in retention, more efficient use of the student's time, easy access to group study over networks, better feedback to faculty, and organized self-assessment and self-pacing. Faculty and traditional classrooms are not replaced, but another dimension is added that greatly improves the efficiency of learning. As this new process of using technology to improve learning develops, more students will be able to take advantage of this type of instruction.

At large research institutions such as VCU, technology is enabling new teaching and learning models which are designed to improve learning productivity, reduce labor intensity, and provide new ways of delivering education and service to students which improving the quality of instruction.

Virginia Commonwealth University is committed to making fundamental and substantive change in the way it fulfills its mission. *A Strategic Plan for the Future of VCU* is the blueprint for this change

THE VCU STRATEGIC PLAN AND GOALS

VCU's Strategic Plan defines the future role of information technology in support of the University's academic and administrative programs. The Plan states that technology will be used to deliver traditional education to the University, the community, the Commonwealth, the nation and the World. VCU is developing its plans to include cooperative instruction with its peer institutions using the technologies.

The vision that has emerged recognized that technology can benefit learning when it:

- allows a student to take a more active role,
- allows a teacher to express the content of a course in more than one format,
- affects students by using techniques that reach various learning styles,
- broadens the array of resources brought to a classroom and the student's workstation,
- increases the opportunities for interactions between teachers and students and among students.
- increases the productivity of those who support the learning environment.

Instructional computing in the next decade will be symbolized by communications using network connectivity between machines, office to office, classroom to library, teacher to student, and the campus to the world. Isolated desktop machines will no longer be the model. The next revolution will be less about the technology of computation than about access to information and ways of sharing information. Consequently, this revolution will involve most members of the college and university communities, not only those who have been traditional beneficiaries of technology. In the new environment, every instructor or student working alone at their office desk or working with others in any campus classroom will access not only the powerful tools of the desktop computer, but also the networked applications and information resources of the university and the world beyond.

The plans envision high-bandwidth network connection to faculty offices and classrooms, network ports distributed throughout the campus, and high-bandwidth/telephone access from off-campus sites or residences. Classrooms will be equipped with systems for displaying prepared lecture material and sharing information resources and there will be on-line processing of grades and other student records. From the desktop, the user will search and retrieve a wide variety of library materials, including multimedia, international journals, databases, reference works, and scholarly discussion groups. Envisioned is a new methodology for faculty to conduct and publish research, create and deliver lectures, and interact with students. The speed and scope of change in instruction methods promised by the new technology is unprecedented in educational history and will require unequivocal institutional support not only to create the infrastructure to make this possible but also to meet the need for faculty motivation and training. These plans call for institutional policies to encourage individual faculty to make the required investment of time and effort. The institution could provide incentives for faculty development in this area for retention, promotion and tenure purposes, or support faculty with well-defined projects for experimenting with new technologies and innovative ways of employing them in the teaching, learning, and research processes.

Achieving these goals will move these institutions toward becoming fully integrated "virtual universities" utilizing asynchronous learning networks in which students, faculty and staff are linked by electronic mail, two-way interactive video, on-line processing, electronic databases, library services, multimedia-on-demand, and other information technologies without regard to physical locations. The potential benefits of moving in this direction include:

- enhanced quality of instruction,
- access to information and library resources,
- high levels of support services to existing students,
- increased access to academic programs by non-traditional students,
- improved effectiveness in uses of limited human, program and financial resources,
- net revenue streams to offset infrastructure and operating costs, and
- incentives to faculty to develop new educational materials.

A VISION OF INFORMATION TECHNOLOGY AT VCU

A *Strategic Plan for the Future of Virginia Commonwealth University - A Report of the Commission on the Future of the University* states:

> Perhaps nowhere is change more rapid that in the area of computers and information technology. Electronic classrooms that mix computers with audio-visual technology and contain workstations instead of desks; first-rate libraries that contain no printed materials; and nationwide distance-degree programs that can reach millions of households are among the new technologies that are changing the structure and delivery of higher education.
>
> Technological changes involve increased automation, increased use of computers and increased development of high-speed communication systems; these developments will impact personnel in virtually every function of the University. Advances in office technology and communications will create new and more efficient ways of performing routine administrative and academic support tasks. User-friendly technologies will attract more members of the University community as users. Multimedia workstations and their associated networking infrastructure will augment or substitute for traditional teaching methods and advances in computer technology will enable the research of more complex issues.

> Over the next ten years, information technology will drastically increase the options that students have in accessing education; advances in communications technology will reduce geography as a barrier to 'placebound' working adult students. Time and location of instruction in the future can potentially be determined by students, not the institution or instructor.

What should faculty, students, and staff at VCU expect within the next decade? The VCU information technology environment will be user-focused. There is a natural tendency for those in charge of running technology to focus more on optimizing the efficiency of the machines than on making the environment more efficient for the people who use the technology. The focus of information technology at VCU will be on faculty, students, and staff.

In the future, all faculty offices will have high speed network connections and modern workstations to interact with colleagues at VCU and around the world, communicate with students, and fulfill their administrative duties. Their administrative tasks will be easier due to new software applications that focus on the task at hand, not the requirements of a specific administrative computer system. Faculty teaching also will be enhanced, and faculty will benefit from better support for teaching. A faculty instructional technology resource facility will help with the development and production of technology-based instructional modules that can be used to enhance a traditional lecture, to support a student-directed learning module, or perhaps be part of a complete multimedia course being developed in collaboration with a colleague at a different university. E-mail and video-mail will enable faculty to interact with their students and conduct discussion groups. These functions will be available from home, as well as on campus, since VCU will extend its network throughout the Richmond area. VCU is committed to providing faculty with an environment that enhances their academic life.

Students also will find VCU a better place to pursue their education. In a traditional 'synchronous learning' environment, faculty teach at a given time and place dictated by the institution, and not necessarily convenient to either the students or instructors. In contrast, in the emerging technological 'asynchronous learning' environment, it is the student who controls the time, place and manner of learning. The Internet, kiosks and voice response system, and other information technologies will support, enhance, and customize teaching and learning. As VCU establishes its new technology infrastructure, an increasing number of educational components will be delivered asynchronously. Students will be able to view 'on-demand' a digitized version of a film, for example, that is archived on a superserver and transmitted to their PC or TV using the VCU network. As this new learning mode of multimedia education-on-demand evolves, students will have greater flexibility in arranging their schedules and choosing an information source that best meets their learning style.

Staff, too, will find their environment more productive as VCU moves aggressively to reduce the amount of paper that flows through the University. Using the same network and information systems as faculty and students, those that carry out the necessary administrative functions will have new tools and streamlined procedures to make their efforts more productive.

INFRASTRUCTURE REQUIREMENTS

There are several infrastructure elements required to effectively use technology in teaching and learning.

Electronic Campus and Digital Library

VCU is rapidly becoming an "electronic campus," providing access to all major resources through an ubiquitous network. This fiberoptic network connects all buildings and residence halls at VCU to a "Digital Library." The ubiquitous network infrastructure is the baseline required to support the concept of a "virtual university" and asynchronous learning, as shown in Figure 1. The "Digital Library" will provide faculty and students with access both on and off campus to a full range of information technology resources (voice, data, video) in an integrated, networked educational environment. It also will facilitate local and statewide access to full-text articles and publications, electronic library services, databases, multimedia presentations, a central repository of CD-ROM materials, interactive television, and a wide variety of other material including slides, graphics, and video.

Authoring Workstations

State-of-the-art multimedia workstations must be available to faculty for scanning and digitizing images, video, and audio, and they must be loaded with complete editing tools to produce professional quality work. VCU is equipped with SGI, IBM and Apple authoring workstations and software tools, including image editors (PhotoShop), video editors (Premiere, D-Vision) and authoring packages (Persuasion, PowerPoint, ToolBook Authorware, Hypercard, Action and Director). Other resources available to faculty include scanners and digitizing stations to convert source material from work processors, VHS tape, laserdisc, CD-ROM, illustrations, and artwork. Full video production facilities including a video taping studio, hand-help video cameras for off-site work, digital, video and sound editing studios, and in-house support for creating VHS tapes and CD-ROMS.

Electronic Classrooms

Another element of the required infrastructure is the "electronic classrooms," equipped with high-resolution projectors, quality audio systems, and microcomputers with high-speed network access and presentation software. Faculty using these classrooms connect to a local or remote server, and access a wide variety of digitized materials to enhance a classroom lecture under their individual control. This concept is illustrated in Figure 1. VCU has classrooms equipped with large-screen video projection systems, Macintosh and IBM-compatible computers, and network connections. Although delivery of full-motion video remains limited, several programs at VCU (e.g., the School of Pharmacy and the Department of Radiology) are delivering content which requires the delivery of full motion streamed video utilizing ATM networks.

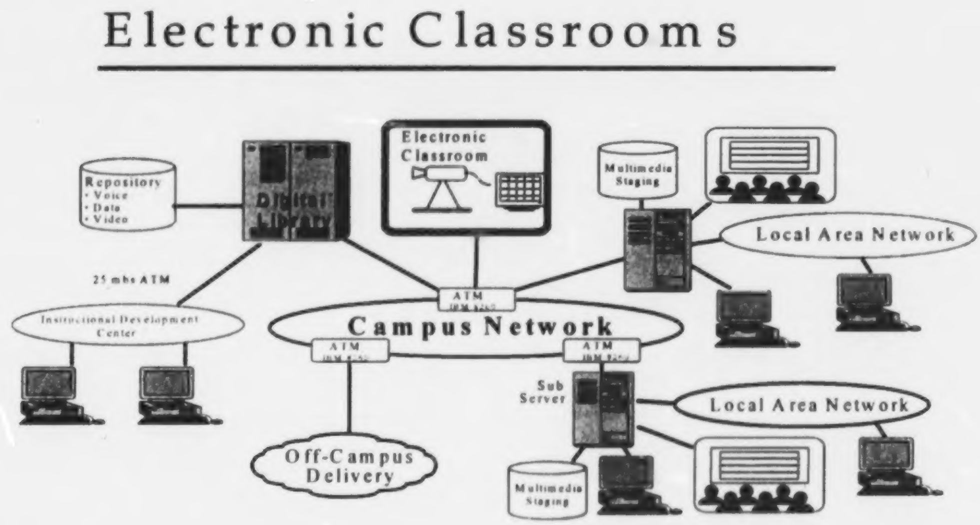

Figure 1: The Electronic Classroom provides a mechanism for delivery of content and a facility to access content from the Digital Library and other network resources.

Virtual Classrooms

The evolution of the "Digital Library" and products such as Lotus Notes and VCU's *Web Course in a Box*™ (WCB) are extending teaching and learning beyond the walls of the classroom. The authoring workstations provide the capacity to "digitize" lectures which can be edited, indexed and stored along with course materials. Both the lectures and materials can be retrieved later to supplement existing classroom instruction, either as stand-alone video, or more likely integrated with interactive multimedia presentations. Several systems for interactivity are being used to encourage conferencing and interaction between the faculty and students participating in this "virtual university". Initially, this was accomplished through electronic mail, bulletin boards and newsgroups. Today, VCU is actively promoting the use of the Web for instruction and using Lotus Notes and WCB to create these courses. To date, VCU has delivered slow motion video over ATM network to a multimedia classroom in the School of Pharmacy. At VCU, there are approximately 100 courses that distribute instructional materials on the Web, half of which were created with WCB. With these tools, students and faculty can communicate electronically whenever they like. Assignments can be given and received electronically. Faculty can hold "virtual" office hours, freeing them from rigid schedules, and enabling students to obtain information quickly. Although the method for student/faculty interaction will change, these technologies should enhance the quality of interaction and improve it over current levels. VCU has experienced tremendous success with an accredited Master Degree program in Health Care Administration which utilized the "virtual university" concept.

The infrastructure requirements continue to change with rapid advancements in technology and to take advantage of innovation, higher education must restructure IT Services. The traditional academic computing or library services role in audio, visual, or media instructional support faces restructuring to support asynchronous learning and other non-traditional instruction.

IMPLEMENTATION OF LOTUS NOTES AND THE DIGITAL LIBRARY AT VCU

If we define the business of VCU as delivering and receiving information, then we can define the information flow as a set of objects which comprise the work and processes. An Information Object will be defined as a single unit of information within the University. In figure 2, we attempt to begin to define these Information Objects as they relate to VCU.

The Digital Library and Defined Information Objects
Single Units of Information Flowing within VCU

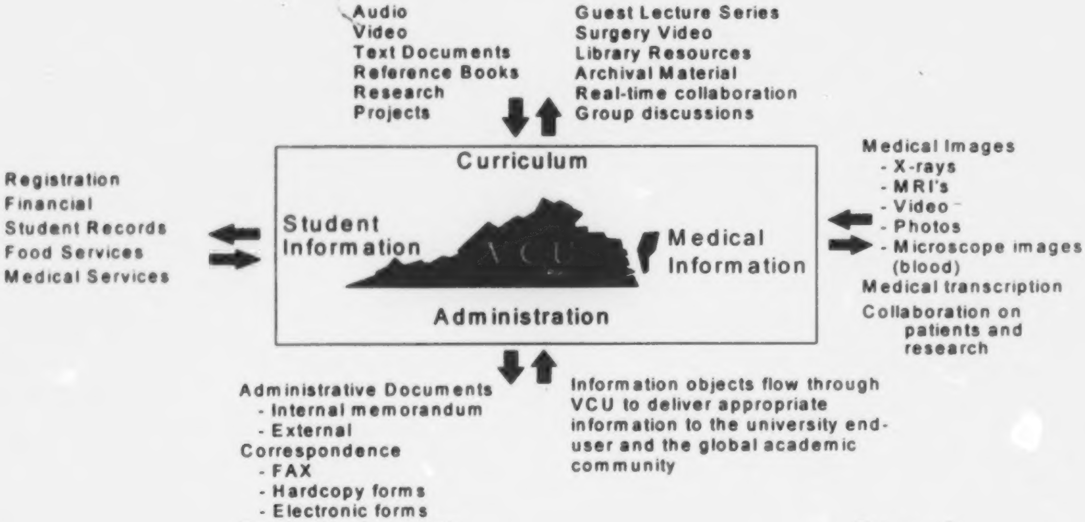
Audio
Video
Text Documents
Reference Books
Research
Projects
Guest Lecture Series
Surgery Video
Library Resources
Archival Material
Real-time collaboration
Group discussions
Curriculum
Registration
Financial
Student Records
Food Services
Medical Services
Student Information
VCU
Medical Information
Administration
Medical Images
- X-rays
- MRI's
- Video
- Photos
- Microscope images (blood)
Medical transcription
Collaboration on patients and research
Administrative Documents
- Internal memorandum
- External
Correspondence
- FAX
- Hardcopy forms
- Electronic forms
Purchasing documents
Information objects flow through VCU to deliver appropriate information to the university end-user and the global academic community

Figure 2

Once we have Information Objects defined, the next concern is how to enable the communication and passage of information. Lotus Notes provides transfer of messages and information between machines and enables scaleability of these applications across the University. Lotus Notes allows applications to be network independent since it manages the transfer of messages across a heterogeneous computing environment.

Education-on-demand provides the perfect opportunity to establish a set of workgroup processes which can be integrated to provide the successful delivery of information via a series of communications activities delivering information objects to the global community. IBM's Lotus Notes and IBM's Digital Library provides a mechanism for control and management of the various types of information objects which will be involved in VCU's delivery of a new 'asynchronous learning' environment to its students. Yet when reduced to its simplest component, it basically involves the flow of information to end-users.

Information flows in two directions for the University. First there is that which is delivered to the student and the global academic community, including the information created in the process of that delivering that product. We have some control over the format of this internal information and its style. External information is delivered to the University in an uncontrolled manner, but with the proper tools, management and recommunication of this information can be easily achieved.

To begin to handle the various information objects flowing into, around, and out of VCU, Lotus Notes coupled with the Digital Library will be installed in a pilot to enable the group communications required by education-on-demand by integrating multimedia electronic mail (CCmail), scheduling, address book and calendaring (Organizer). These products are an ideal vehicle for education-on-demand, with the ability to deliver an e-mail to a student ID with a weekly folder containing objects that contain a video clip of a surgery, text on the procedure, audio discussion of procedure or a means to schedule a weekly collaborative session with the professor at a prescribed time.

RESTRUCTURING IT SERVICES USING THE TOOLS OF ASYNCHRONOUS LEARNING

Prior to 1980, Information Technology support units typically operated a mainframe and provided software consulting support to the users of these large, timesharing machines. When the personal computer revolution began, academic computing centers invariably took the lead in offering all levels of support: consulting, training, even repair. A decade later, personal computers became ubiquitous and in the 1990's, the use of instructional technology finally matured and client/server technologies forced a change in the infrastructure we had relied upon for decades. IT support units are now struggling to find creative ways to support a new generation of computer users with increasingly sophisticated applications and desktop equipment, while rebuilding their aging hardware infrastructures.

At VCU, the increased demand for IT service is beginning to change the IT units in many ways:

Faculty Support

The role that IT service units play in faculty development is changing. In the past the training has been primarily given in brief training sessions of one to three hours, and has been a scatter-gun approach which usually only provides resources and training to the 10% of the faculty interested in being at the leading edge of the technology. Academic computing and library services staff have offered "brown bag" lunch series in the use of various information technologies to faculty, staff, and students. This series of training sessions has grown as new databases and new technologies are introduced and created in the academic environment. Please visit our Web site at: **http://www.vcu.edu/web/training**. VCU is now developing ways to provide intense hands-on training for all interested faculty members in all the newest technologies of multimedia and asynchronous learning. Workshops and institutes have been developed to provide instructional support to faculty to create content that can be accessed over the University's data network, the Internet, and World Wide Web. Faculty members come away from training ready to take an active role in planning and implementing changes in the way they teach. At VCU, strategies are being developed to support a faculty mentoring program. These programs seek to provide the tools, training, and release time for interested faculty to develop multimedia programs and serve as future expert resources to other faculty within their own schools and colleges.

Instructional Development

Teaching faculty are only now learning to use multimedia workstations to deliver instruction. A new faculty support unit was created at VCU as part of the restructuring of IT units. The Instructional Development Center (IDC) was created with staff reassigned from University Computing Services, Library Services, and Media Services. The mission of this new unit is to support faculty use of instructional technology through consulting training, project development, and creation of teaching media. IDC works with individual faculty and with academic units in the planning and development of computer-based instructional projects, using both network solutions such as World Wide Web and stand-alone authoring environments such as Authorware.

Given its limited staff, the IDC strives to maximize the assistance it can offer by creating tools to enable faculty themselves to create computer-based learning materials. IDC is committed to helping faculty to become knowledgeable about innovations in instructional technology and in finding effective ways to use technology to enhance learning. Each summer a series of seminars is hosted by IDC; summer and winter institutes offer longer-term learning opportunities. IDC's Web site at: **http://www.vcu.edu/mdcweb/** features a "self-study lab" with information on learning resources as well as locally created demos and tutorials. VCU is testing Lotus Notes *Domino* as a hybrid approach to deliver MPEG standard video through the integration of a CD-ROM in a client with internet access.

The Virtual-Consultant

The traditional role of IT support staff has been to provide Socratic style support sometimes in a small training classroom but usually one-to-one and face-to-face. As faculty and staff demands increase and the base of support fails to expand at the same rate, the consultant will need to learn how to provide consulting services without ever seeing the person face-to-face. In fact, the consultant will use the same tools that are being developed for teaching and learning at the "virtual university".

Library Services

Libraries and librarians have assumed new roles to support information technology. The explosion to electronic resources and the demands by consumers to access those resources anytime and regardless of location have forced changes in library operations and management. New statewide networks like the Virtual Library of Virginia, better know as VIVA, have been created to maximize state funding to negotiate licensing agreements with on-line vendors of bibliographic and full text databases. Libraries are creating digital collections of unique in-house materials and making them available on the Web. Like their computer colleagues, librarians play a vital role in faculty development by teaching faculty to use and organize digital information.

Access to the Ubiquitous Network

Providing full Internet access is a major support issue. VCU, with the majority of students living off campus, has in addition to wiring their campuses, outsourced Internet access from home to a private Internet provider. This piece of the infrastructure offers additional support challenges. The infrastructure to create this function for 2,000 faculty, 5,000 staff and 20,000 students is prohibitively expensive in today's changing market. In fact, it is likely that the entire infrastructure will need to be changed in two years. Today's 28.8 kb modem over analog dial-up may be today's technology choice, but ISDN, cable modems and 56KB modems are to increase the speed in the next several years as the need for higher and higher bandwidth to the desktop are dictated by the emerging technologies of the World Wide Web and the Digital Library (e.g., full motion video and high resolution imaging). VCU is exploring higher bandwidth alternatives with both Bell Atlantic and Continental Cable.

The role of IT support has changed because the level of access to information has become so pervasive. In a brief twenty years, requirements have increased from supporting a few mainframe users with terminals on campus to supporting students, educators, and staff who demand better service from their office, home, or residence hall.

Broad Band Communications: Evolution & Applications

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1. ABSTRACT

With the development of word wide telecommunications, the growing needs of SDH termination, ATM termination onto narrow band switches, simplified network management and service continuity lead to the smooth evolution towards the use of broadband technology for narrowband services based on the existing narrow band infrastructures. the market demand for network integrated solution results in the concept of Full Service Network (FSN), which integrate all narrow band services, broadcast video services, interactive video on demand services (IVOD), videotelephony, multimedia services etc.. For the future market competition and business prospectiveness , Shanghai Bell together with Alcatell Bell is jointly evolved in the development of P3*, a project, which allows the smooth evolution from narrow band switch S12 to MPSR (multipath self routing) based broad band switch environment and FSN applications. This paper describes the concepts of P3* and its implementation strategies, presents the general FSN architecture and its services, shows some access implementation applications.

2. INTRODUCTION

A new generation of information superhighway is about to enter our homes. The increasing interest and need for higher bandwidth switched services and availability of high speed, high quality transmission systems based on fiber optics, has lead to the development of a new generation of broadband switches and a range of SDH line transmission equipment. For cost effectiveness and service continuity, it is important to evolve the existing communication infrastructure to the use of broadband switch technology based on the existing communications infrastructure. The broadband FSN will break the conventional telecommunications, lead the world to a broad range of multimedia full services, i.e. combine video, sound and voice to provide the end users with interactive TV services, broadband video services, all narrowband services,, information consultation service, multimedia services, etc..

3. EVOLUTION TO BROADBAND COMMUNICATIONS

3.1 DEFINITION

The Project of evolving from narrowband to the use of broadband communications, A1000 - S12 P3* is the implementation of evolution strategy, which allows smooth evolution of the use of broadband technology for narrowband service based on S-12. narrowband switches.

3.2 RATIONAL FOR P3*

The market needs for Synchronous Digital Hierarchy (SDH) termination, Asynchronous Transfer Mode (ATM) termination, network management solution and the network integrate solution, competition for cost effectiveness, and service continuity result in the concept of P3* project. The enabling technology of Multi Path Self Routing (MPSR) can not only switch ATM cells, but also switch SDH synchronous payloads, which allows a smooth evolution towards introduction of new users and network services, maintaining the investment of existing narrowband equipment.

During the evolution from narrowband to broadband switch, the following two arguments should be considered. First, as we know, A great amount of development efforts is spent to S-12 hardware and software development, this efforts should be reused for narrowband functions in a broadband environment to avoid Double development. Second, the success and penetration of broadband service/users is still uncertain, and the introduction price of broadband will be high, upgrade S12 narrowband with broadband hardware provide means to reduce the risk and lower the price of broadband technology introduction.

If we take the new services evolution into account, the availability of high speed, high quality transmission systems result in the development of SDH transmission line, the high bandwidth flexibility and efficiency of some service performance introduces the ATM network elements. The project P3* is aimed at goals of coupling narrowband to SDH backbone and providing service interworking with ATM network by offering SDH termination, ATM termination and service continuity to the existing narrowband switch.

3.3 EVOLUTION STRATEGY

The P3* has four releases, they are:

3.3.1 OFF-LINE REPLACEMENT OF DSN (DIGITAL SWITCH NETWORK)BY MPSR

The technology used For broadband switch is MPSR, the mapping of 64kbps in Multislot sells is necessary to meet the needs of the broadband switch fabric. The DSN routing mechanism should be translated to the MPSR routing mechanism, the hardware replacement should has no impact onto s12 software.

3.3.2 ON-LINE REPLACEMENT OF DSN BY MPSR AND PROVISION OF SDH TERMINATION

The replacement procedure is described as following:

- the DSN plane to be replaced is disabled, the traffic will continue on the remaining planes
- the traffic-less DSN plane is replaced by MPSR technology.
- the "replaced" plane is put into operation, thus a hybrid switch fabric can use the technology of both DSN & MPSR.
- After longtime testing and acceptance, the customer can select three choices of backing on the remaining conventional planes, using hybrid switch fabrics or updating to all MPSR fabric network by replacing all DSN planes.

3.3.3 _ATM TERMINATION

The MPSR switch fabric has a much high traffic bandwidth when compared to the DSN switch fabric. Therefore after replacement of the switch, it becomes possible to develop ATM termination module directly onto the MPSR, which results in a true broadband switch solution.

3.3.4 _INTERWORKING WITH NARROW BAND AND BROAD BAND FUNCTIONALITY

After the MPSR fabric, SDH termination and ATM termination is introduced in S-12 narrowhand switch, the new switch can provide both narrowband services and broadband interfaces. Instead of stand-alone broadband switch, the new switch will combine narrowband and broadband service modules in a single switch, and the advantages of cost-effectiveness, easy operation and integrate management of a single network make it possible to stand a potential position in the future competitive market.

The following figure shows the architecture of the new single network, which will support all narrowband services, SDH termination, ATM broadband services and interworking functionality between broadband and narrowband networks (see figure 1).

4. BROADBAND APPLICATIONS: FULL SERVICE NETWORK

4.1 DEFINITION

Full Service Network, also known as Information Super Highway, is an open network of generic service platform, which offers broadcast video services, all narrowband services, interactive video services, videophone, multimedia services, etc. for both residential and business users.

4.2 GENERAL FSN ARCHITECTURE

The FSN mainly consists of four subnetworks (service provider network, broadband switch network, Access net work and digital home network) plus service gateway and network management (see figure 2). The FSN network provides an end to end solution for the network and service provider.

The broadband switch is an Asynchronous Transfer Mode (ATM) based switch, which provides the connection oriented broadband bearer service (CCITT Rec. F811). This service offers semi-permanent connections of variable bandwidth between user terminals. The connection performed on ATM switch is implemented by means of virtual path connection (vp - trail) or virtual channel connection (vc - trail).

The service provider usually is a computer of high performance with large database. The information stored in the service provider can be integrated into a multimedia database offering management facilities and various media storage capabilities for information consultation, interactive services, multimedia services etc..

Digital Home Network is parts of the user primitives in Full Service Network, it is used as drop and In-house network in conjunction with the full service network. The Line Interface Module is the interface between DHN and access network. At the entry of homes, DHN is connected to the In-house terminals by the passive drop network termination. DHN can be well designed to meet the needs of the service evolution towards the interactive multimedia services.

The access network represents the most significant portion of network investment, there are various alternatives available before determine which access approach best meets the needs of your business.
The full service network emphasizes on the interface to switch network (provided by access node) and digital home network (provided by multimedia line interface modules). There are mainly four access networks: ADSL (asynchronous digital subscriber loop) access network, HFC (hybrid fiber coax) access network; APON(ATM passive optical network) access network and ATM access network.

The network management is implemented by an intelligent software system (or an expert system) installed in a workstation, it manages the configuration of ATM cross -connection and all services over the network, monitors network events and status. The user friendly graphical format on a screen on the workstation makes it easy for operators to know all management functions over the network.

The service gateway acts as

- the mediator between the network, service provider and end users. It co-ordinates the session between service provider and end users, and allow users to find most suitable service provider.
- directory navigator which enable service providers to promote their directory services even with preview facilities.

4.3 BROADBAND ACCESS IMPLEMENTATION STRATEGIES

4.3.1 ADSL (ASYNCHRONOUS DIGITAL SUBSCRIBER LOOP) SYSTEM

ADSL technology permits telecomm operators to reuse there existing twist pair to provide broadband services over the existing telephone infrastructure. ADSL system has its inherent nature of asymmetric links, which is suitable for asymmetric services (eg. Interactive Video ON Demand). The latest technology allow ADSL to carry up to 6Mbps data stream (1.5-6 Mbps downstream and 16-640Kbps) to support bi-directional information transmission between central office and residential users.

4.3.2 HFC (HYBRID FIBER COAX) SYSTEM

CATV carries are currently migrating from coax based network to a hybrid fiber/coax (HFC) plant to provide the advanced digital services. The HFC architecture provides high quality of transmission and reduces the price of the coax based trunk network. The communication resources of the HFC network is RF spectrum. The latest technology shows that up to 1GHz RF spectrum can be used over the HFC network, although the spectrum assignment is not standardized until now, but as usual, the frequency from below 70M is assigned to the narrowband services (eg. ATM signaling, POTS and management signals)
the frequency from 70 MHz to 300 MHz is assigned to the existing CATV analogue TV programs, the digital information (video and data) will be carried in 300 - 860 MHz range and the upper part of the spectrum, above 860 MHz, will be reserved for future advanced services.
As a Full Service Network, a HFC system usually has Host Digital Terminal (HDT) at access node, which handle the cablephone services and interface to the existing narrowband switches. The HDT connects to the fiber node and further links to the coaxial network to the residences. By using frequency division multiple

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access (FDMA), the digital video signals "combined" with analogue TV signals, cablephone signals, digital data signals and management signals can be transmitted between access node and user primitives where the broadband optical network termination (BONT), coax network termination (CNT) and set-top-boxes (STB) split the desired signals to implement application specific interactive services.

4.3.3 APON (ATM PASSIVE OPTICAL NETWORK)

The APON technology provides high speed access capabilities. It is suitable for Fiber To The Home (FTTH) deployment, which uses small optical network unit (ONU) for single Video On Demand (VOD), POTS interface and data terminal; and for Fiber To The Building deployment, which uses modular ONU to connect multiple POTS, VOD and dada terminals. APON devices combined with ATM Service Unit (ASU) and dedicate LIMs to provide the ATM business subscribers with different type of broadband and narrowband services.

4.3.4 ATM ACCESS SYSTEM

The ATM access is based on the ASU technology, it allows connections of different access networks to broadband switch network making the FSN access network independent. In other words, the ATM access technology allows the access network mix and evolution.

From commercial effectiveness point of view, the ADSL and HFC are strongly recommenced nowadays to permits Telecom Operators to reuse their existing twisted pair and coax CATV infrastructures. The FSN has it's inherent broad band and interactive capabilities, which will lead to the dream of word wide networked multimedia or information super highway.

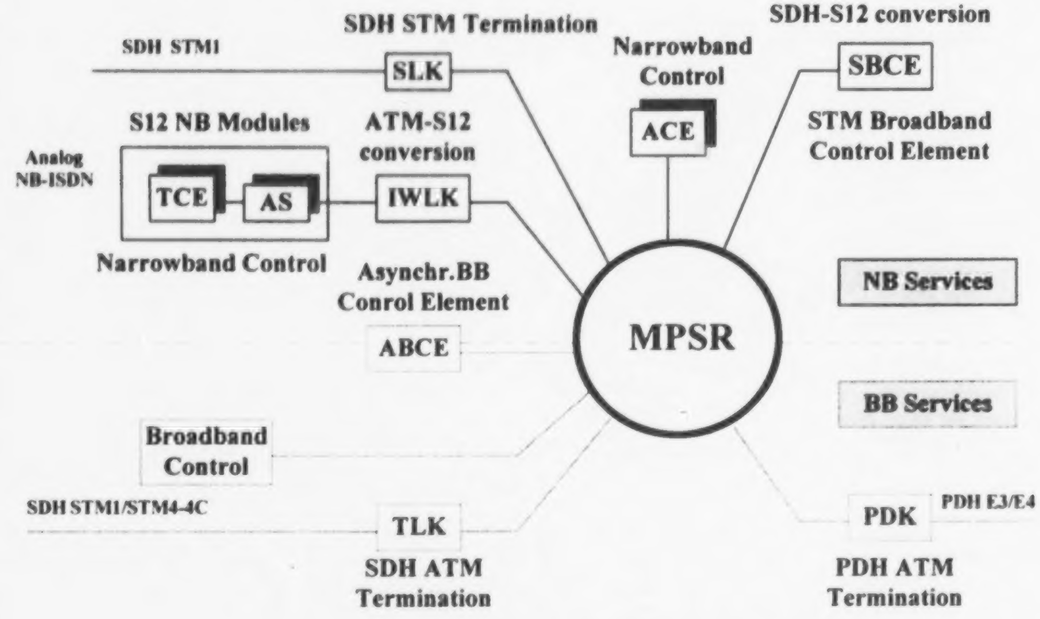
SDH STM Termination
SDH STM1
SLK
Narrowband
Control
ACE
SDH-S12 conversion
SBCE
STM Broadband
Control Element
S12 NB Modules
ATM-S12
conversion
Analog
NB-ISDN
TCE
AS
IWLK
Narrowband Control
Asynchr.BB
Conrol Element
ABCE
MPSR
NB Services
BB Services
Broadband
Control
SDH STM1/STM4-4C
TLK
PDK
PDH E3/E4
SDH ATM
Termination
PDH ATM
Termination

Figure1. S12 Narrowband-Broadband Switch on MPSR

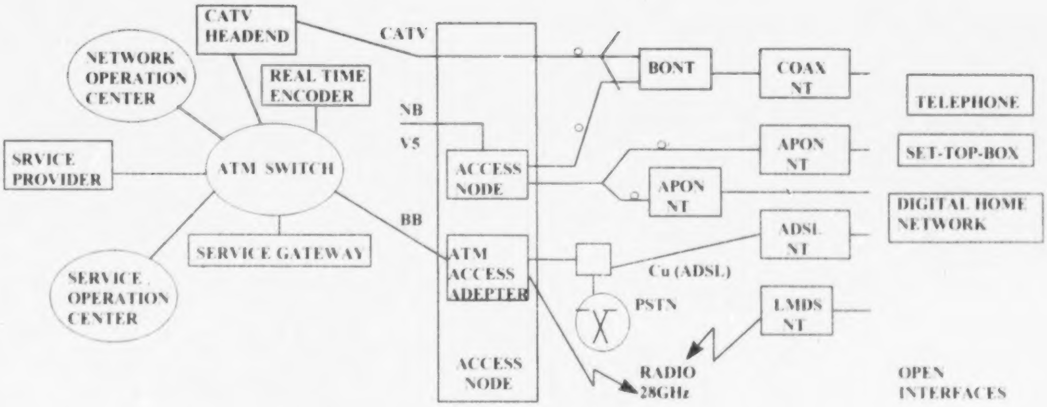
CATV HEADEND
NETWORK OPERATION CENTER
REAL TIME ENCODER
SRVICE PROVIDER
ATM SWITCH
SERVICE GATEWAY
SERVICE OPERATION CENTER
CATV
NB
V5
BB
ACCESS NODE
ATM ACCESS ADEPTER
ACCESS NODE
BONT
COAX NT
APON NT
APON NT
ADSL NT
LMDS NT
Cu (ADSL)
PSTN
RADIO 28GHz
TELEPHONE
SET-TOP-BOX
DIGITAL HOME NETWORK
OPEN INTERFACES

Figure2. General Architecture of Full Service Network

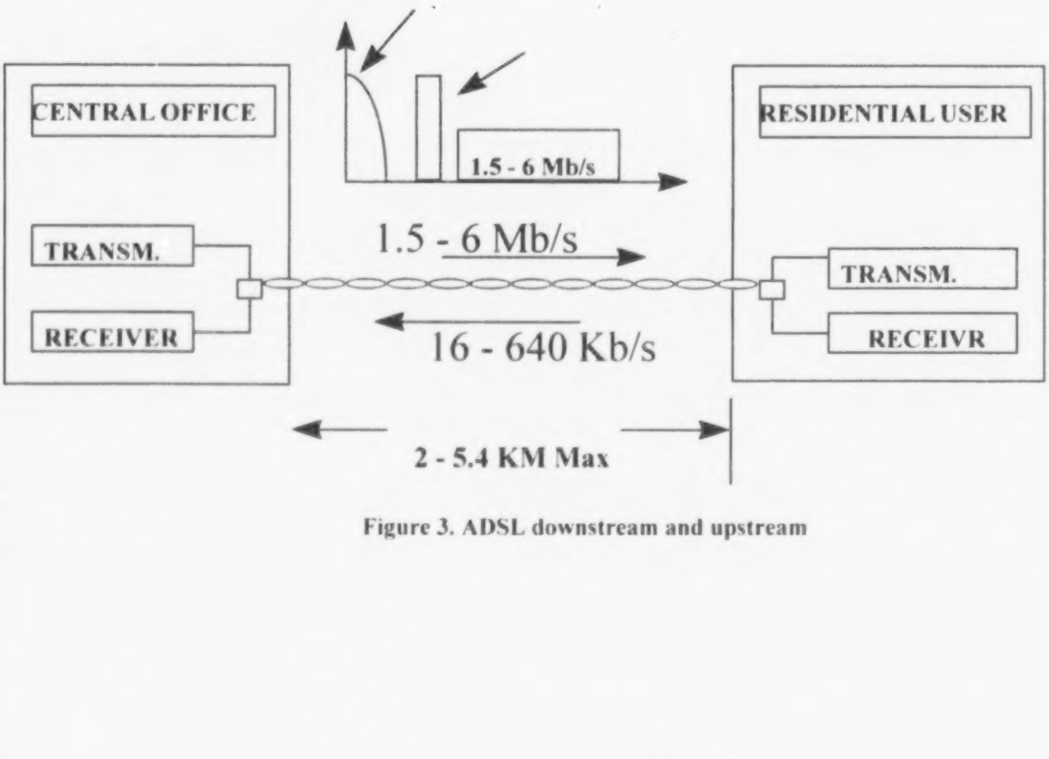
CENTRAL OFFICE
TRANSM.
RECEIVER
1.5 - 6 Mb/s
1.5 - 6 Mb/s
16 - 640 Kb/s
RESIDENTIAL USER
TRANSM.
RECEIVR
2 - 5.4 KM Max

Figure 3. ADSL downstream and upstream

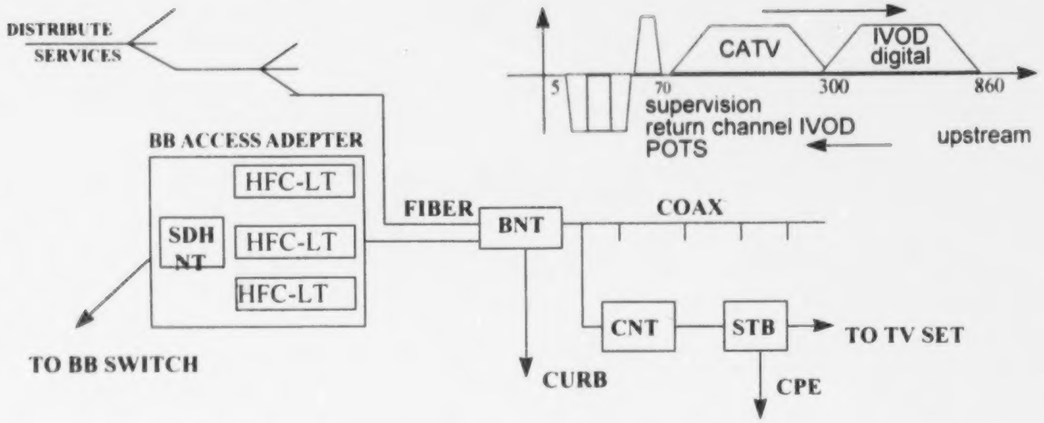
DISTRIBUTE
SERVICES
BB ACCESS ADEPTER
HFC-LT
SDH NT
HFC-LT
HFC-LT
TO BB SWITCH
FIBER
BNT
COAX
CURB
CNT
STB
TO TV SET
CPE
CATV
IVOD digital
5
70
300
860
supervision
return channel IVOD
POTS
upstream

Figure 4. HFC access and frequency assignment

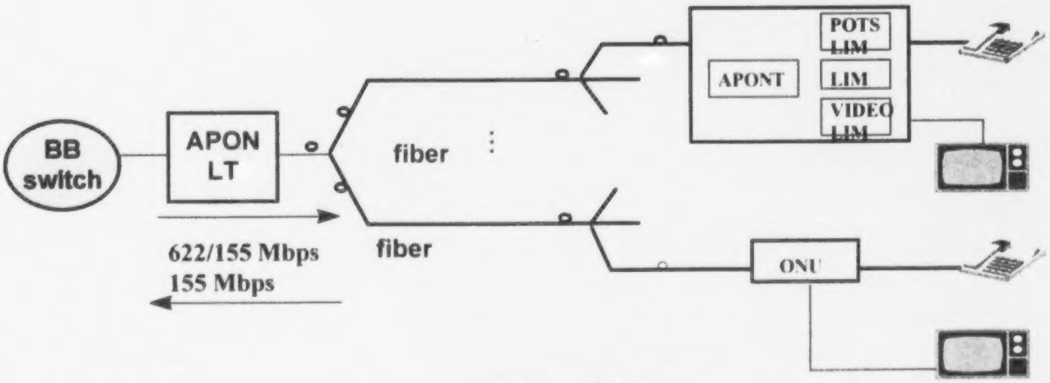
BB switch
APON LT
622/155 Mbps
155 Mbps
fiber
fiber
APONT
POTS LIM
LIM
VIDEO LIM
ONU

Figure 5. APON access

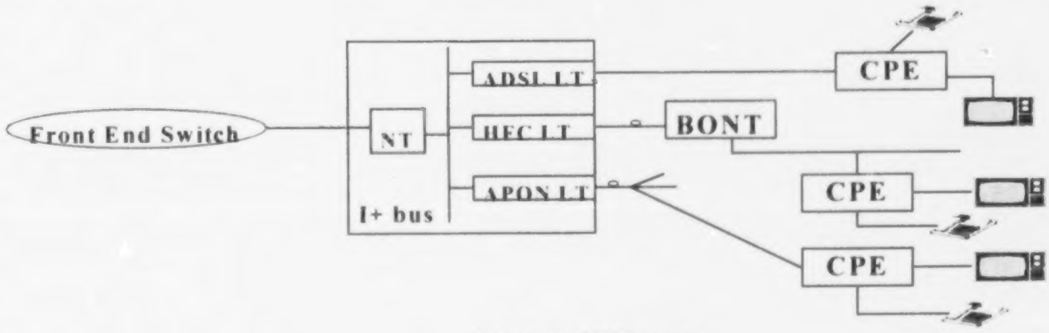
Front End Switch
NT
I+ bus
ADSL LT
HFC LT
APON LT
BONT
CPE
CPE
CPE

Figure 6. ATM access

5. REFERENCE

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[2]. Tang Jihua, "Alcatel Video-On-Demand Network Service Demonstration For Telecom Geneva'95", ICII'96 , Beijing, China

[3].Wu Zhonghua, R.Dierckx, , "Full Service Network", ICII'96 , Beijing, China

Supplying Method of PSTN Services under the Considerations of B-ISDN Network Evolution

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ETRI, ISDN Call Processing Section

ABSTRACT

In this paper, we present the supplying method of PSTN services under the considerations of B-ISDN network evolution. The existing STM network may not be replaced entirely by the ATM network in the near future. It is important to add the interworking functions to ATM switching system to supply services provided by the existing networks. We propose the interworking subsystem which uses the internal protocol instead of UNI, NNI protocols between ATM and STM switch. Also we present the software structure of ATM switching system including interworking subsystem. And we discuss the network evolution toward B-ISDN using proposed interworking subsystem.

Keywords : B-ISDN, PSTN, Interworking, ATM, STM, CLAD, Network Evolution

1. Introduction

The growing demands of customers for more advanced and sophisticated services require extension of the existing PSTN (Public Switched Telephone Network) and narrowband ISDN to broadband ISDN (B-ISDN), which is provided on Asynchronous Transfer Mode (ATM). Many companies such as Alcatel, AT&T, NTT which already developed ATM switching system, have an endeavor to provide the existing STM service with B-ISDN[1][2][3].

The existing network based on the STM (Synchronous Transfer Mode) principle may not be converted easily to the ATM network in the near future. There are a few cases, in general, in which it is indispensable to add the PSTN interworking function to the existing ATM switching system in order to support the same level of services as that currently provided in the existing network: when there are demands on PSTN subscriber services in the places where ATM services are provided; or when it becomes necessary that the existing PSTN switching system be replaced by a new one due to lifetime expiration. Thus it has become a general trend that STM nodes are replaced by ATM nodes with interworking facilities.

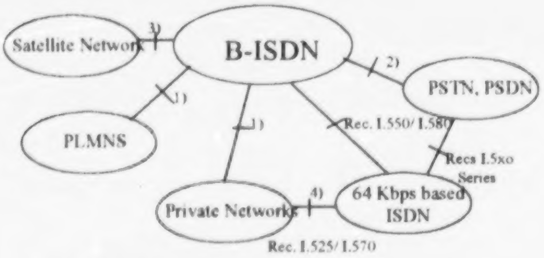
For these reasons, we propose, in this paper, IWS (Inter-Working Subsystem) for the ATM switching system interworking with PSTN which is the on-going research in ETRI (Electronics and Telecommunications Research Institute). The proposed IWS is connected to the ATM switch fabric, already developed in ETRI, by 155Mbps IMI (Inter Module Interface) link. All of the signals and data messages are transferred through the IMI links.

This paper is organized as follows. Section 2 provides an overview of network interworking and international standardization. Section 3 proposes the ATM switching system architecture with IWS. Section 4 discusses the network evolution toward the B-ISDN network and in Section 5, conclusions are drawn.

2. Standardization of Interworking

2.1 Recommendations on B-ISDN interworking

Considering services which are available in B-ISDN, there will be a need for interworking with other networks such as PSTN, PSDNs, PLMNs (Public Land Mobile Networks), satellite networks as well as private networks. Recommendations which relate to B-ISDN interworking are shown in Figure 1. This figure describes relationships among the many Recommendations on B-ISDN interworking with other networks[4].


Satellite Network
3)
B-ISDN
2)
PSTN, PSDN
1)
PLMNS
1)
Rec. I.550/ I.580
Recs I.5xo Series
4)
Private Networks
64 Kbps based ISDN
Rec. I.525/ I.570

1) It is not yet defined
2) It is not yet defined except PSPDN which is specified in Rec X.3b at this moment (ITU-SG 7)
3) The need is for further study
4) Recommendation I.525 for less than 64 kbit/s-based networks and Recommendation I.555 for frame mode bearer service.

Figure 1. *Recommendation status for B-ISDN interworking*

2.2 B-ISDN Interworking Scenarios

Interworking scenarios between B-ISDN and other public networks (e.g. PSTN, PSDNs) are classified into two types as depicted in Figure 2. One is an indirect interworking with other public networks, and the other is a direct interworking between B-ISDN and other public networks.

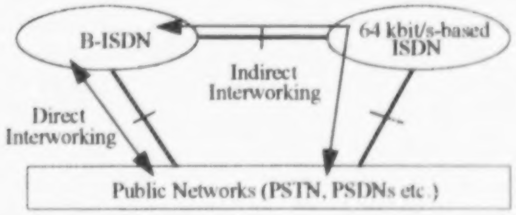

B-ISDN
64 kbit/s-based ISDN
Indirect Interworking
Direct Interworking
Public Networks (PSTN, PSDNs etc.)

Figure 2. *B-ISDN interworking configuration*

with public networks

1) Indirect Interworking Scenario
Interworking between B-ISDN and existing public networks (e.g. PSTN, PSDN etc.) take place indirectly. That means an interworking between B-ISDN and other public networks is then 64 kbit/s-based ISDN connection with other public networks.

2) Direct Interworking Scenario
In this scenario interworking between networks operating at bit rates of less than 64 kbit/s and B-ISDN takes place directly i.e. without intervention of 64 kbit/s-based ISDN. So, in this case, B-ISDN has several interworking functions for interworking with each public network, and some new Recommendations are needed for this.

2.3 B-ISDN interworking with PSTN

To give end-to-end telephony based services (e.g. voice and voice band service), B-ISDN interworking with PSTN is required. In this case, service features are restricted by a bearer service of PSTN. There is no distinction between UNI and NNI interworking of PSTN from protocol point of view, and AAL type1 in B-ISDN side is used. Interworking configuration for this is described as in Figure 3.

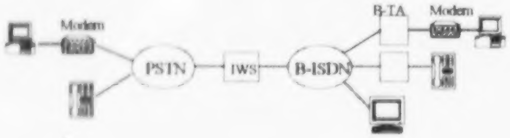

Modem
PSTN
IWS
B-ISDN
B-TA
Modem

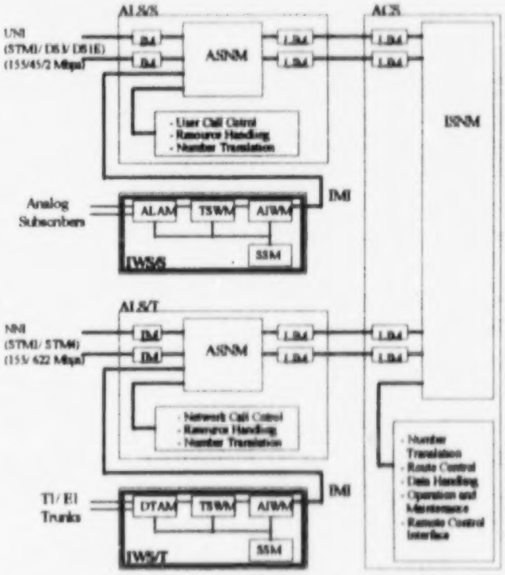
Figure 3. *B-ISDN-PSTN Interworking Configuration*

3. Interworking Architecture

3.1 ATM Switching System

In ETRI, development of the ATM switching system, called TDX-ATM, has recently been completed. These ATM systems also have been used for the high speed broadband backbone network in Korea. The architecture of TDX-ATM system is a distributed structure for real time processing. It is composed of self-routing switch for high speed cell exchange and diverse rate access link interface such as STM-1, STM-4, DS-3, DS-1E level. And it is modular architecture to meet a variety of growing demands such as heterogeneous traffic application, versatile signal capability and increasing capacity. Transport network consists of switch network, interface module and network synchronization. Control network consists of call processing part, inter-module interface, signaling handler, operation and maintenance part.

Figure 4 describes the architecture of ATM switching system interworking with PSTN. There are two methods in ATM-PSTN interworking: 1) subscriber interworking through IWS/S and 2) trunk interworking through IWS/T.


ALS/S
ACS
UNI
(STM1/ DS3/ DS1E)
(155/45/2 Mbps)
IM
IM
ASNM
LIM
LIM
LIM
LIM
- User Call Control
- Resource Handling
- Number Translation
ISNM
IMI
Analog
Subscribers
ALAM
TSWM
AIWM
SSM
IWS/S
ALS/T
NNI
(STM1/ STM4)
(155/ 622 Mbps)
IM
IM
ASNM
LIM
LIM
LIM
LIM
- Network Call Control
- Resource Handling
- Number Translation
- Number Translation
- Route Control
- Data Handling
- Operation and Maintenance
- Remote Control Interface
IMI
T1/ E1
Trunks
DTAM
TSWM
AIWM
SSM
IWS/T

IM : Interface Module
LIM : Link Interface Module
ASNM : Access Switching Network Module
ISNM : Interconnect Switching Network Module
ALS : ATM Local Switching Subsystem
ACS : ATM Central Switching Subsystem
IWS : Inter-Working System
AIWM : ATM Inter-Working Module
TSWM : Time Switch Module
SSM : Signaling and Service Module
ALAM : Analog Line Access Module
DTAM : Digital Trunk Access Module

Figure 4. *Architecture of ATM Switching System interworking with PSTN*

And now, we are developing the IWS for PSTN subscriber call processing. We use a general purpose processor which controls the ATM switching system interworking with PSTN. The IWS includes (1) the IPC (Inter Processor Communication) transfer function for sending/receiving the messages with ATM switching system; (2) AAL1 (ATM Adaptation Layer 1) cell assembly and disassembly function for mapping voice data to ATM cell streams and (3) the IMI link interface function for physical connection.

3.2 Basic Interworking Concept

We propose the basic concept of interworking system use the direct interworking scenario. The proposed InterWorking Subsystem is implemented using STM switch fabric within the ATM switching system. So, it use the IPC (Inter Processor Communication) messages instead of UNI, NNI protocols between IWS and ATM common control part. Figure 5 shows the simplified block diagram of ATM-PSTN interworking concept.

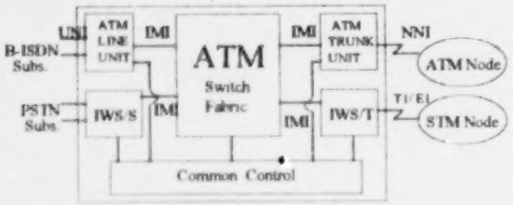

B-ISDN Subs.
UNI
ATM LINE UNIT
IMI
ATM
Switch Fabric
IMI
ATM TRUNK UNIT
NNI
ATM Node
PSTN Subs.
IWS/S
IMI
IMI
IWS/T
T1/E1
STM Node
Common Control

Figure 5. *ATM-PSTN interworking concept*

3.3 IWS Configuration

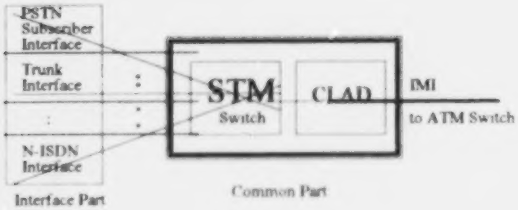

PSTN Subscriber Interface
Trunk Interface
N-ISDN Interface
Interface Part
STM
Switch
CLAD
IMI
to ATM Switch
Common Part

Figure 6. *IWS configuration for flexible extending*

Figure 6 depicts the flexible extending IWS configuration. It is composed of common part and interface part. Common part consists of STM switch and AAL1 cell Assembly and Disassembly part, which converts voice data into ATM cell stream. Interface part is possible to extend the existing STM switch interface (e.g. PSTN subscriber, trunk, frame relay, N-ISDN etc.). In this paper, even though we just mentioned about the ATM switching system with PSTN, all of the existing STM functions can be provided in ATM switching system if we develop another interface parts as N-ISDN, frame relay etc.. In this case, it is easy to reuse the software and hardware of the existing STM switching system when we implement the ATM-STM interworking system.

3.4 Software

We describe the software structure of IWS applied to ATM switching system and specify the relationships between software blocks. According to the replacement of call control blocks and the change of configuration for subscribers and trunks devices accommodated in IWS, the software structure for PSTN interworking in ATM switching system can be applied to the other types of IWS (i.e., N-ISDN, Frame Relay etc.). In Figure 7, we describe the structure of software blocks for PSTN subscriber interworking with ATM switching system.

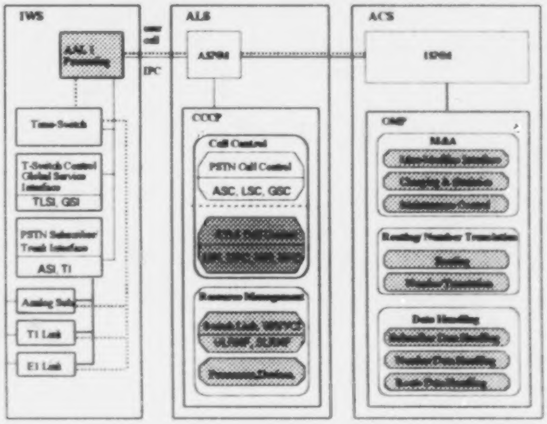

IWS
ALS
ACS
AAL1 Processing
IPC
ASPM
Time-Switch
T-Switch Control Global Service Interface
TLSI, GSI
PSTN Subscriber Trunk Interface
ASI, TI
Analog Subs
T1 Link
E1 Link
CCCP
Call Control
PSTN Call Control
ASC, LSC, GSC
Resource Management
OMP
M&A
Routing Number Translation
Routing
Number Translation
Data Handling

Figure 7. Software Structure for ATM-PSTN interworking

Interworking system software consists of call control part, number translation and routing part, resource management part, maintenance and administration part. The shadowed part of Fig.7 is already developed in ATM switching system except AAL1 processing part. Call control part is devided by ATM and PSTN call control part. The PSTN call control part includes ASI (Analog Subscriber Interface) and ASC (Analog subscriber Call Control) blocks. ASI performs intermediation function between PSTN subscribers and call control software blocks in ALS. ASC performs originating and terminating call/connection control for PSTN subscribers. Also, ASC interworks with IWP (Interworking Process) which performs AAL Type 1 for IPC and user data respectively. ATM call control part include UPI (Usage Parameter Interface) and UPC (Usage Parameter Control) blocks. The number translation and routing part includes NTL (Number Translation in ALS) and NTC (Number Translation in ACS) blocks. NTL performs the translation of prefix number. NTC performs the translation of subscriber numbers and the routing control. The resource management part includes ULRH (User-Network Interface Link Resource Handling) and SLRH (Switch Link Resource Handling) blocks. ULRH performs the allocation/ deallocation of VPI and VCI. SLRH performs the allocation /deallocation of the internal switch link resources.

Besides there are service control blocks such as GSC (Global Service Control), TLSI (Time Switch and Local Service Interface), and GSI (Global Service Interface). GSC interworks with GSI for the operation of announcement devices and conference mixer devices. TLSI performs connection and release of time switches and signaling devices.

When we construct the interworking software as above, the merits and demerits of the ATM interworking subsystem implementation is as followings.

(1) Demerits
- increasing the load and the complexity of the existing ATM switching system,

(2) Merits
- more efficient network infrastructure and management,
- cost-effective to add the ATM switching system adjacent in STM node,
- the maximum utilization of the existing system's hardware and software.

3.5 Call Processing Software Structure

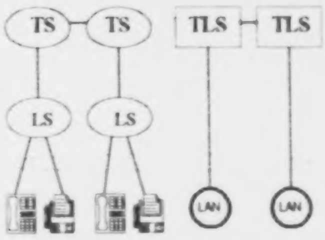
The proposed ATM interworking switching system works as a gateway between ATM and STM networks, its software is expected to handle various type of calls such as PSTN, B-ISDN and interworking calls. The call processing software of interworking can be developed in either a hybrid way or an integrated way. The hybrid way handles the ATM calls and the STM ones separately, but the integrated way handles the ATM calls and STM ones uniformly. The interworking functions between ATM and STM networks is performed by providing the protocol conversion within the system. The STM software is modified in order to incorporate the ATM resource control functions. This software structure can minimize the modification of the existing call control functions caused by adding STM capability in ATM mode, and can provide flexibility for separating ATM and STM functions according to network evolution scenarios.

4. NETWORK EVOLUTION

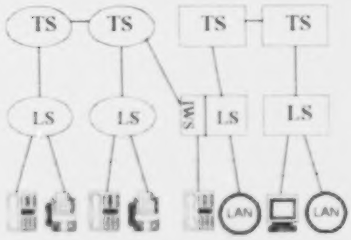
In the considerations of the existing and new services, there are various methods in the network evolution. Figure 8 shows how the expected network could be introduced in an evolutionary ways when we use the proposed IWS.

At the first step, it provides high-speed data communications as early ATM services. Cell relay and frame relay services of the ATM networks are provided to meet early business user demands. The ATM networks should be introduced as overlay networks to provide these services immediately. Fig 8-a) shows introduction of ATM network.

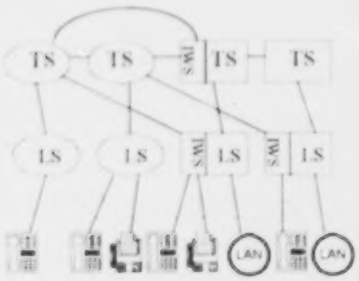
In second, it begins to provide the multimedia services. Video services as well


TS
TS
TLS
TLS
LS
LS
LAN
LAN

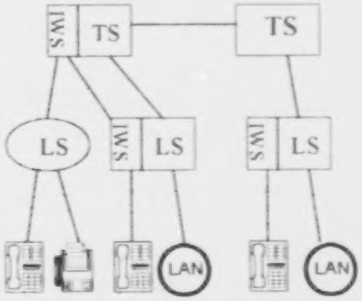
a) Introducing the ATM network


TS
TS
TS
TS
LS
LS
IWS
LS
LS
LAN
LAN

b) Providing the diverse services as multimedia


TS
TS
IWS
TS
TS
LS
LS
IWS
LS
IWS
LS
LAN
LAN

c) Interworking between ATM and existing node


IWS
TS
TS
LS
IWS
LS
IWS
LS
LAN
LAN

d) Evolution towards B-ISDN

TLS : Transit/Local Switch

TS : Transit Switch LS : Local Switch

▭ ATM node ⬭ STM node

Access Network

Figure 8. Network Evolution toward B-ISDN

as data services are starting to be offered, and multimedia traffic is gradually increasing. ATM interworking nodes with STMs including both ATM switches and STM switches will be economical in low ATM penetration areas. Cell Assembly and Disassembly functions between ATM and STM switch fabrics are implemented. But in this time, it is impossible to connect between ATM terminals and STM terminals. It is only possible to connect between STM terminals over ATM switch fabrics. ATM switching systems provide transit interworking functions between STM switching systems, and subscriber interworking functions with STM subscribers. The interconnections between STM switching fabrics over ATM switch fabrics are performed through Switched Virtual Circuit.

At the third step, because ATM traffic, especially voice traffic, is increasing, interworking functions to connect between ATM terminals and existing STM terminals are required in the network. By using interworking function, the STM nodes can be changed into new ATM nodes when they become necessary that the existing PSTN switching systems be replaced by a new one due to lifetime expiration. We have more benefits that the local networks are first changed into the ATM networks where the ATM services demands are greatly increasing areas, while transit switch is early changed into ATM networks in the places where the ATM services demands are low.

At last, the network evolve to full ATM transit networks. When most communication use the ATM, the existing STM transit networks will be integrated into an ATM networks by replacing STM nodes with ATM nodes. In the future, this will evolve into a full ATM networks.

5. CONCLUSIONS

We present the supplying method of PSTN services under the considerations of B-ISDN network evolution. We considered the interworking basic concept and discussed the IWS which performed ATM-PSTN interworking function within ATM switching system. Proposed interworking subsystem used the internal protocol which performs UNI, NNI protocols between ATM and STM switch. Also we present the software structure of ATM switching system including interworking subsystem. It is easy to reuse the software and hardware of existing PSTN switching system. The structure of interworking subsystem is a flexible and easy to extend the existing STM network not only PSTN, but also N-ISDN, frame relay etc.. Proposed interworking subsystem also enables a stepwise flexible evolution from PSTN, N-ISDN based networks toward the B-ISDN network.

6. REFERENCES

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[4] ITU-T SG13, "*General Arrangement for B-ISDN Interworking*", Draft Recommendation I.5GA, July 1995.

Regulatory Issues on CATV and Telecommunications Convergence in Korea

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Abstract

Technological progress made it possible to provide telecommunications services over CATV networks or broadcast services over telecommunications networks. Therefore, the creation of appropriate regulatory framework to incorporate this 'network convergence' is requested to prepare for 'information society'. Under these circumstances, most of countries in Asia-Pacific region are taking effort to cope with the new trend. This paper reviews present regulatory framework of Korea and tries to find out new policy framework which takes into account of the network convergence phenomenon.

1. Introduction

The Korean telecommunications industry has recently undergone significant changes since 1990. In 1990, the monopoly by Korea Telecom(KT) was given up, and the second operator (DACOM) was allowed to enter the international telephone market. The scope of competition has been expanded further as new operators were authorized to participate in the mobile and long-distance telephone market in 1994 and 1995, respectively.

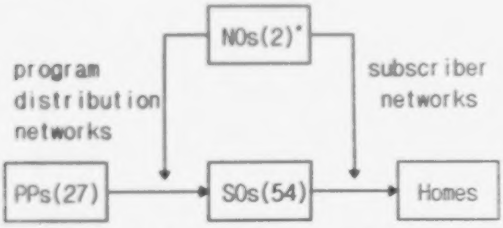
However, One of the most important recent events in the Korean telecommunications industry seems to be the introduction of the modern multichannel CATV in March 1995. The reason why the CATV industry becomes one of the important factors in telecommunication policy is that the development of new technology now allows the competition between the telecommunication networks and the CATV networks and enables each of the networks to provide both telecommunication and broadcasting services. Some of the developed countries including the UK, Japan and the USA already allowed the CATV networks to provide telecommunications services, and have been using the CATV networks for elimination of bottlenecks in local loops and for the early establishment of national information infrastructure.

In Korea, the CATV industry is still regarded as a pure broadcasting industry and so the CATV networks are strictly prohibited from providing the telecommunication services while the telecommunication networks are also prohibited from offering the broadcasting services. Moreover, the CATV system operators are not allowed to own CATV networks, while Korea Telecom (the dominant PTO) and KEPCO (Korea Electric Power Co.) have been designated as network operators. From the perspectives of industrial structure, this makes it more difficult to use CATV networks as telecommunications infrastructures or to bring competition into local loops. Therefore, to maintain the continuous growth of the CATV industry in Korea and to build the national information infrastructure (KII) essential for the information society, it is required to review current regulatory framework and prepare a new regulatory framework.

This article presents a short overview of the existing laws and policies for the regulation of the CATV and telecommunication networks, and the existing state of CATV industry. Based of this overview, the article reviews the necessity of a new regulatory framework for the convergence of CATV and telecommunication networks in Korea. The main issues to be addressed by such a framework include cross-ownership, creation of multiple system operators, participation of large firms, integration of regulatory authorities, content regulation and interconnection.

2. Current Regulatory Framework and Policies

The introduction of the modern multichannel CATV in Korea was first considered in the late 1980s. At that time, there were only 3 terrestrial television channels broadcasting less than 12 hours a day. This was far short of what would have been required for the satisfaction of diverse information needs that steadily increased in step with the rise of per capita income. Since then, the introduction of the modern multichannel CATV appeared among the election pledges during the 13th presidential election campaign in 1987. In April 1990, the Modern Multichannel CATV Promotion Committee was organized in the Ministry of Information(MOI), and it started the preparation for the introduction of CATV. The CATV Act proposed by the Committee was passed in December 1991, and in March 1995, after the 3-year preparation period, the era of the modern multichannel CATV was opened in Korea.



As of July 1996, Korea Telecom entered into contract with 17 PPs and KEPCO with 10 PPs for the supply of program distribution networks, while Korea Telecom entered into contract with 21 SOs and KEPCO with 32 SOs for the supply of subscriber networks.

Figure 1. Structure of CATV industry

According to the CATV Act, the CATV industry in Korea consists of 3 types of operators(see Figure 1): program providers (PP), system operators (SO) and network operators (NO). PPs are the companies that provide the content for the CATV channels by producing or purchasing programs and sell them to SOs, whereas system operators market and sell CATV services to the homes. NOs build and operate both the distribution networks(which connect PPs to system operator headends) and the subscriber networks(which connect the headends of SOs to the homes).

The current CATV Act strictly regulates business activities of these 3 types of operators(see Table 1). The creation of multiple system operators (MSOs) as well as the cross-ownership across SOs, PPs and NOs is prohibited. CATV operators are prohibited from entering the telecommunication market. Large firms, mass media and foreigners are prohibited from capital and/or management participation in SOs.

Table 1. Regulatory framework for the CATV industry

	SO	NO	PP
Telecommunications services	P	P	P
Foreign capital participation	P	P	A (up to 15%)
Vertical itegration (SO+PP+NO)	P	P	P
Consolidation of Sos into MSOs	P	–	–
Licensing period	3 years	–	–
Participation of Large Firms	P	–	A

key : P : Prohibited A : Allowed.

The licensing and regulation authority over PPs and SOs belongs to the Minister of Information, while such authority over NOs is held by the Minister of Information and Communications(MIC). Currently, the whole country is divided into 116 areas and centering around big cities the SOs for 54 areas were selected at the first stage(see Table 2). The SOs for the remaining 62 areas are expected to be selected within one or two years. Each of SOs is guaranteed a monopoly licence for 5 years, and should pay the monopoly licence fee of up to 10% of SO's total annual sales in return for the monopoly right. In addition, 27 PPs were selected in August 1993 and two NOs (KT, KEPCO) were licensed in November 1993.

Table 2. CATV licences allowed

Region (city/ province)	Total areas	Selected SOs at first stage (January 1994)	Remaining areas
Seoul	21	21	-
Busan	8	8	-
Daegu	6	6	-
Inchon	5	5	-
Kwangju	2	2	-
Daejon	2	2	-
Kyungki	20	2	18
Kangwon	5	1	4
Chungbuk	5	1	4
Chungnam	6	1	5
Chonbuk	6	1	5
Chonnam	8	1	7
Kyungbuk	9	1	8
Kyungnam	11	1	10
Cheju	2	1	1
Total	116	54	62

3. Current situations of the CATV industry

The CATV industry in Korea is experiencing a rapid growth, as it achieved the home passed rate of 50% (4.05 million households) and the penetration rate of 13% (1 million households) by June 1996, one year and three months after its introduction(see Figure 2). This is a remarkable growth rate, when compared with the cases of developed countries like the UK, Japan, the USA and Canada who spent 10 years to achieve 30% home passed rate and 8 to 10 years to obtain 1 million subscribers. If the current trend persists, 70% home passed rate and the 1.5 million subscribers will be attainable by the end of 1996.

There are broadly 3 reasons for this rapid growth. First, the most important reason is that there had been only 4 terrestrial television channels and these small number of channels could not satisfy diverse information needs of the audience. As can be expected from this background situation, there were many applications for subscription from the beginning so that many of the applicants had to wait for several months until they could really watch CATV. Second, the regulatory authorities separated SOs and NOs, and entitled NOs to own and operate CATV networks, which reduced SOs' burden of investment. The authorities also designated KT and KEPCO, who had enough previous experience of network construction, as network operators. This made the early establishment of networks possible. Third, Korean government provided financial supports including tax reductions and low-interest-rate loans.

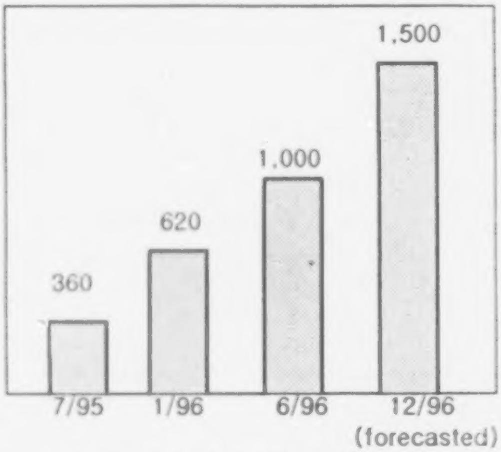


Figure 2. Trend of CATV subscribers (unit: 1000)

4. Necessity of a New Regulatory Framework

So far, the regulatory framework in Korea clearly separated telecommunications industry and CATV industry, and put a strict ban on the possibility of infrastructure convergence. However, the latest technological developments made it possible for each of CATV networks and broadband telecommunication networks to provide both types of services. Therefore, in many countries CATV networks are not regarded simply as broadcasting networks, but considered as useful means for the supply of various services in telecommunications and broadcasting areas. With the rapid spread of CATV networks, it is time for the regulatory regime in Korea to reexamine the current regulatory framework that strictly separates telecommunications and CATV, and to prepare a new one for the integration of telecommunication and CATV networks and the integration of services.

The necessity of the convergence of telecommunications and CATV can be summarized as follows.

4.1 Establishment of KII

To be one of the leading countries in the information society in 2000s, Korean government is driving forward the establishment, by the year 2015, of the national information infrastructure(KII). The establishment of KII is expected to require a total of 45.2 trillion won (approximately 58.7 billion dollars), of which 1.8 trillion won (approximately 2.3 billion dollars) will be rendered by the government and the remaining 43.4 trillion won (approximately 56.4 billion dollars), by the private sector. However, it is difficult to draw private investments because of the worries about the insufficient demand for broadband telecommunication networks under the current regulatory framework, which prohibits the supply of entertainment services through telecommunication networks and the supply of telecommunication services through CATV networks. In addition, to avoid investment overlaps and to utilize limited investment resources in an efficient manner, we need to revise the current regulatory framework in the direction that allows the utilization of CATV networks (which is constructed as broadband networks from the beginning) as local broadband infrastructure for KII.

4.2 Removal of bottlenecks in local loops

After 1990, telecommunication policies in Korea are becoming more competition-oriented. In international, long-distance and mobile telephone service markets, the competition is already intense with new operators entering these markets. However, the local telephone service market is still under the monopoly system. The monopoly system in the local telephone service market is based on some reasons, such as the economies of scale in this market, the worries over investment overlaps, and the worries over the deterioration of universal services. However, as can be seen in the case of the UK, these worries can be resolved when we utilize CATV networks as local loops. Since the use of CATV networks allows not only the provision of traditional telecommunication services, including voice telephony, but also the offer of new multimedia services, we can introduce competition into the local telephone market without the worries of investment overlaps, and can get a help in removing the bottlenecks in local loops at an early stage.

4.3 Promotion of the CATV industry

Despite its rapid growth, we cannot be too much optimistic about the future of the CATV industry in Korea because of the following problems and threats.

- The threat of teleco's entry into the entertainment market: the VOD plan of KT
- Huge deficit (51.6 billion won by December 1995) and uncertain prospect for its resolution within a short period of time
- The extension of broadcasting hours of terrestrial TV channels (from previously 12 hours to 16 hours or more now)
- The introduction of domestic digital satellite broadcasting (7/96) and the infiltration by neighbor countries in satellite broadcasting

The CATV industry in Korea is facing these types of threats just within 1 year after its introduction, while the CATV industry in developed countries is experiencing these problems after decades from its first introduction. Therefore, CATV operators hope strongly for the permission for the provision of telecommunication services through CATV networks to resolve the accumulated deficits early and to facilitate the spread of CATV services.

5. Future perspectives

The Ministry of Information and Communications, which is now in charge of telecommunication policies, has begun to review the plans that allow the provision of telecommunication services through CATV networks for the catch-up with the technological developments, for the early introduction of competition into local loops, and for the early establishment of KII. The possibility of this change has been shown in the interim research report (Future Direction of Telecommunication Policies) published by KISDI, a research institution for telecommunication policies under MIC, in June 1996. This report recommends MIC to open up competition in local loops by utilizing the alternative telecommunications infrastructures such as CATV networks and wireless local loops.

If a decision to allow the provision of telecommunication services through CATV networks were to be taken in Korea, we can expect two types of competition scenarios depending on whether or not KT owns CATV networks. The first scenario is to exclude KT's participation in the ownership and management of CATV networks and to press for divestiture of the existing CATV networks from it. This is because we cannot expect the effect of infrastructure competition in such a situation where the incumbent telecommunication operators own the CATV networks. The exclusion of KT's ownership of CATV networks would increase the amount of competition, but there may be advantages from network integration which could be lost. The second scenario is to allow the provision of telecommunication services through CATV networks as are owned by KT. In this case, the integration of networks can be maintained. However, we can expect only the limited competition, because KT will take a passive position for the provision of telecommunication services through CATV networks as it does not want CATV networks to come into local loops. Therefore, in case regulator allows PTOs' ownership of CATV networks, regulator have to devise proper safeguards, such as open network access for service providers, for the development of a fair and open competitive environment.

It is expected that the provision of telecommunication services through CATV networks will give a significant impact on the incumbent telecommunication operators and subscribers whichever scenario is adopted. As for the operators, the competitive position of DACOM, who currently has to depend on KT's local loop for its long-distance and international telephone services, will be reinforced. As for the subscribers, they will be able to use telephone service at much lower prices, since telecommunication services are provided through already established CATV networks. However, because of the worries about the credibility and quality of services, CATV networks will be used more for households than for businesses at the initial stage.

6. Issues in Regulatory framework

Allowing operators to provide both types of services over one network gives the opportunity of various services to users through the developments of related technology and services and provides traditional services at much cheaper prices through the enhanced competition among operators. However, the introduction of competition, simply by itself, does not solve every problem. Along with the introduction of competition, there remain many issues to be addressed in regulatory terms.

6.1 Cross-ownership of SOs and NOs

Note that SOs and NOs are separated and SOs are not allowed to own networks. So, even when permitted to provide telecommunication services, the CATV operators have difficulty in providing telecommunication services independently as in the UK or Japan. We should allow SOs' ownership of networks to utilize CATV networks as a competing infrastructure.

6.2 Multiple system operators

The current regulatory framework prohibits the creation of multiple system operators. However, in telecommunication business, the extension of the regional boundary is the core of competitive strategy. Since there are on average only 150,000 potential subscriber households per single SO region. SOs will have difficulty in securing subscribers for telecommunication services due to the limited regional boundary if the MSO is not allowed.

6.3 Participation of large firms

Since large firms are not allowed to participate in SO business, in most cases financially-weak small-and-medium sized firms are now the largest shareholders of SOs. Note that telecommunication business requires both large investment and technological capabilities. It is difficult to obtain those investment and technology for telecommunication business only with financially-weak small-and-medium sized firms and without the participation by large firms

6.4 Integration of regulatory authorities

According to the law now in force, the regulatory authorities of CATV industry are separated to MIC and MOI, respectively. This may cause the conflicts of interest between MIC and MOI, and obstruct the convergence of CATV and telecommunications. To be prepared for the information society, we need to consider the integration of regulatory authorities to carry out the integrated broadcasting and telecommunication policies.

6.5 Contents regulation

Under the current regulatory framework, it is not clear to which of broadcasting and telecommunications the services(contents) on the boundary (for example, VOD) belong for regulation. Traditionally, there have been very strict regulations on the contents of programs in broadcasting (for example, political neutrality, regulations on pornography, and regulations on distortion). However, in telecommunications, there are no such particular regulations on the contents except for the protection of privacy. Therefore, there could be a big difference in regulations on the very same content depending on its classification. To resolve such problems, we need to set up new principles for the regulation on the contents based on the convergence of telecommunications and broadcasting.

6.6 Interconnection

If the provision of telecommunication services over CATV networks is allowed, we will see many small-size telecommunication operators. In such a situation, we inevitably need to prepare a standard interconnection arrangement. If we leave the issues of interconnection only to the commercial arrangement among operators, the supply of telecommunication services by CATV operators with weak bargaining power will be delayed.

7. Conclusion

So far, the regulatory regime for telecommunication policies in Korea has regarded CATV networks simply as the infrastructure for CATV services, and did not examine the possibility of using the CATV networks for telecommunication policies. However, as the provision of telecommunication services over CATV networks is being made possible through technological innovations. CATV networks are now either used or planned to be used as the networks for telecommunication services in many developed countries.

The regulatory regime in Korea is recently paying attention to the possibility of CATV networks as telecommunication networks. The regime also reexamines the current regulatory framework that does not allow the provision of telecommunication services through CATV networks. If the provision of telecommunication services over CATV networks is allowed, we can achieve early establishment of KII aimed at, by the year 2015, the elimination of bottlenecks in local loops, and the supply of various services to subscribers at much lower prices. Therefore, we need to work out as soon as possible a new regulatory framework appropriate for the situations in Korea to facilitate the telecommunication and CATV convergence.

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LMDS and Broadband Local Networks for Asia

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1. ABSTRACT

Two central trends are defining the next major phase of network evolution and market opportunity: broadband networking and wireless access. Traditional telco and CATV companies have proposed various technologies for making wireline networks broadband-capable, but most solutions are expensive and limited in scope. Broadband wireless networks based on Local Multipoint Distribution System (LMDS) technology will enable a quantum leap in capacity for switched network access, and introduce a competitive "third force" in the local loop. This paper provides a summary of LMDS features, and market opportunities and challenges for the Asia-Pacific region.

2. INTRODUCTION

The Asia-Pacific information "Super Highway" is virtually built. Fiber optic and other fast transmission routes link most major capitols and economic centers throughout the region. Yet access *to* the super highway is restricted to carriers, traffic resellers and sophisticated corporate end-users. Facilities do not exist to directly connect local residential and small businesses customers to the network backbone at broadband speeds. What is missing is a broadband on-ramp -- a "local backbone" -- to deliver the power and promise of next generation information networking to individual homes and desks.

The most powerful solution for providing ubiquitous and affordable broadband local access is Local Multipoint Distribution System (LMDS) technology. LMDS is a new wireless, cell-based technology that is redefining the economic case for interactive "single-pipe" media networks combining telephony, video services, high-speed data and emerging integrated media applications. It is the first switched local network access technology to bring the power of broadband to the average telephone and CATV consumer, setting the stage for the next giant step toward a true information economy.

3. BACKGROUND

LMDS, which operates in the 28 GHz frequency range, first appeared in commercial telecommunications applications in 1991, when CellularVision received an experimental license from the FCC to build a wireless CATV network in New York. CellularVision's pioneering first-generation analog LMDS system uses frequency modulation (FM) technology to offer 49 channels of wireless cable TV. It is a broadcast network similar to the more dominant wireless cable variant, multichannel multipoint distribution systems (MMDS).

Second generation all-digital LMDS technology is just now coming to market. The digital difference is profound. Rather than merely providing one-way distribution of video programming, digital LMDS makes possible the quantum leap to fully interactive, two-way switched broadband networking in the local loop. In theory, it can delivery as much data downstream (from the network to the consumer) as upstream (from the consumer to the network). This symmetrical capability immediately redefines the potential for high bandwidth interactive applications such as video conferencing, video-on-demand, fast residential Internet access, and highly flexible networked computing.

A "typical" commercial LMDS application can provide a staggering downlink throughput of 51.84 - 155.52 Mbp/s (SONET OC-1 to OC-3), and a return link of 1.544 Mbp/s (T1). This capacity translates into phenomenal potential to provide "full service network" packages of integrated voice, video and high-speed data services. Actual service carrying capacity depends on how much spectrum is allocated to video versus voice and data applications. Assuming that 1 GHz of spectrum is available, an all-video system could provide up to 288 channels of digital broadcast quality television plus on-demand video services. If the system were engineered for voice and voice grade data only, it could serve up to 18,400 main lines (DS0), or about 60,000 consumer telephones, assuming a compression rate of 4:1.[1] In mixed residential and business areas, LMDS operators will likely provide a blend of video and voice services and configure spectrum to meet local market needs. An "average mix" commercial system could offer

156 video channels and up to 7,000 DS0 main lines (without compression), in each cell coverage area. Note Table 1:

Table 1: LMDS Service Capabilities
Channels and Circuits Per Node
Assuming 1 GHz Spectrum

Service Mix	Video	Voice/Data*
All Video	288	0
All Voice	0	18,400
"Average Mix"	156	6,992

*Without Compression
Source: Texas Instruments

Remarkably, LMDS' huge capacity makes possible dedicated T1 service to any customer: *point-to-multipoint T1 network access without a fixed wire connection*. LMDS is also protocol neutral, and can support all major transmission standards for voice and data (ATM), Internet (TCP/IP) and video (MPEG-2).

It is difficult *not* to see LMDS as a revolutionary technology. It is the first local network access technology to enable cost-effective, substantive and simultaneous competition to both local telephone and CATV companies. Industry Canada calls LMDS a "third force": an enabling technology with the potential to redefine the barriers to entry in local telecommunications, introduce meaningful competition, and accelerate the much-vaunted benefits of the information economy.

4. TECHNOLOGY HIGHLIGHTS

The most mature digital LMDS product to date is Texas Instrument's MulTIpoint™, which emerged from expertise gained from various defense-related projects. It completed beta testing in 1994 and volume shipments will begin in late 1997. Hewlett Packard is also approaching a commercial product, through a joint effort with Stanford Telecommunications, Inc. A variety of other major manufacturers and niche suppliers are expected to announce LMDS products this year, the latter principally firms with expertise in advanced RF technology and digital signal processing.

LMDS operates in the largely unused, extremely high frequency range of 27.5 GHz to 29.5 GHz. In the past, these frequencies were used only for deep space communications by NASA and for some military applications. It is expected that most governments will allocate 1000 MHz of spectrum -- contrast with about 50 MHz for cellular or 140 MHz for broadband PCS -- to exploit the full potential of LMDS to deliver bandwidth-intensive, integrated media services. Canada licensed 1000 MHz in two contiguous spectrum blocks in late 1996[2], with future allocation blocks scheduled to be auctioned by 1998. The US has cleared 1300 MHz[3] which is expected to be auctioned in 1997, pending resolution of disputes associated with the local interconnection order stipulated in the 1996 Telecommunications Act. Thailand has cleared 2000 MHz of spectrum, though most countries in Asia do not have established policies for LMDS. Generally speaking, the 28 GHz band is uncluttered, due to the cost and complexity of the electronics required to exploit the frequency.[4]

A basic LMDS network is comprised of an omni-directional or sectorized base station, user antennas with network interface units and/or set-top boxes, and equipment required for wide area network interconnection, such as links to a telephone central office or CATV head end (see Figure 1, next page). The base station is located on transmission towers, while the user antennas -- the size of a dinner plate or smaller -- are positioned on user roofs. LMDS installs quickly (about two hours for a user antenna), has low incremental costs once the basic infrastructure is in place, and very low maintenance.

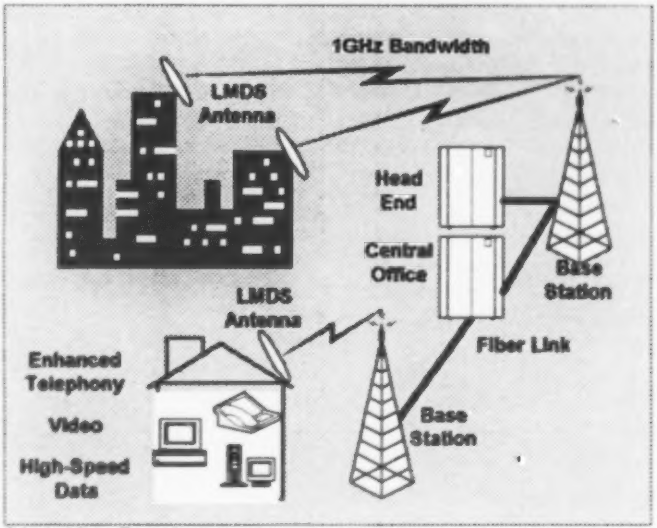
At very high frequencies, the behavior of radio waves creates specific performance characteristics similar to those of light, creating special difficulties. Among them are signal attenuation, interference, and the need for line-of-sight transmission. LMDS signal strength is also affected negatively by rainfall. Environmental obstacles can be overcome by adjusting transmission power, allowing LMDS to achieve landline quality or better, with bit error rates approaching 10^{-9}. Through a combination of reversing the polarity in adjacent cells or sectors, and employing advanced modulation techniques such as quadrature phased shift keying (QPSK), signal interference is cut to a minimum while spectrum re-use approaches 100%.[5]

LMDS is designed to operate in overlapping cells approximately 10 km in diameter. Because the coverage area for each LMDS cell may be partitioned into sub-sectors, it is possible to customize service offerings on a neighborhood scale, to geographic areas as small as 18 sq. km. This modular topology allows tremendous flexibility in capital expenditure planning. Traditional narrowband and broadband networks, by contrast, are saddled with high fixed costs and can only be upgraded on a wide area basis; the cost of providing niche applications such as broadband must be borne by the entire network. With LMDS, users and resellers pay only for the network elements they use. Video basic service packages or advertising can be targeted at individual communities, and "big network" telephony power can be matched directly with market needs. Infrastructure build-out decisions can thus be matched closely with dynamic customer requirements -- and without the financial and technological planning inertia of the installed base.

The incremental aspect of cell-by-cell expansion also suggests dramatically different economies of scale for market entry and break-even. Capital investments in traditional local services networks are enormous, and competitors -- where allowed -- face staggering start-up costs. LMDS will enable entrepreneurs and small investment enterprises to challenge monopoly strongholds.

Figure 1:

LMDS Infrastructure



Adapted from Texas Instruments

5. MARKET CONSIDERATIONS

While countries such as Canada are explicitly encouraging non-traditional investments -- Canadian local telephone and CATV providers were specifically prohibited from applying for 28 GHz spectrum -- each government will pursue a different course for market liberalization. Opportunities will be defined by national telecommunications priorities, and the hazards are many.

Competitive or entrepreneurial LMDS operators do not stand a chance in countries where the regulator has a traditional or protectionist view of local networks: the local network is inevitably the last rock to be overturned in competitive restructuring. If the policy regime is in transition, or if the lines of government authority for telecoms regulation are not clear, a start-up may be granted a license to use the radio frequency, but be denied an operating license to offer telecommunications services. In more liberal environments, they may win all licenses and relevant government approvals, but fail to secure transparent interconnection agreements with dominant operators. Smooth introduction of alternative LMDS networks will be possible only if governments fully understand the economic stimulator effect that removing network capacity constraints will have on local economies: the potential for software and applications development, new consumer services and an improved commercial cycle are enormous.

Existing dominant suppliers of telephony and CATV services may introduce LMDS themselves, but inbred conservatism and technological prejudice suggests that take-up will be slow. Part of the problem is that LMDS presents a radical reassessment of the concept of value in local communications services, and dominant carriers are not prepared to move quickly to adopt a new economic model. LMDS threatens the entire edifice of local service provider's value: scarcity of bandwidth (for telephone companies) and two-way switched broadband (for CATV). Both have held onto the notion of local services as a "natural monopoly" long after competition and deregulation have firmly reshaped interexchange and international services. Why? Established interests have successfully cowed regulators into believing that competition in local services is not economical. LMDS redefines this equation.

Established local service providers could introduce LMDS (if only to pre-empt competitive entry), though a successful service launch would suggest financial ironies. Both telephone and CATV companies have significant investments in making legacy networks broadband capable: telephone companies are embracing XDSL fiber loop systems and switched digital services, while CATV operators are increasingly deploying hybrid fiber coax (HFC). Both solutions are expensive and limited in scope, but are fully compatible with existing facilities; carriers' overwhelming priority is to protect investments in the installed base. Deploying LMDS could cannibalize existing revenue streams, and there is nothing a telephone company hates more than financial uncertainty in core markets. Moreover, telco engineers routinely profess to be "uncomfortable" with wireless RF technology. Nevertheless, there are numerous applications where established providers could benefit from introducing LMDS alongside existing wireline systems. While several major North American telephone companies have completed successful LMDS trials, no known trials have been conducted in Asia to date.

6. OPPORTUNITIES AND CHALLENGES

Some market observers question the need for a third local communications infrastructure when traditional telephony and CATV networks are becoming broadband capable. In countries with high telephone and CATV density, can an economic case be made for introducing another local access platform? The answer is clearly yes. LMDS can provide "bundled" traditional services such as voice, data and video at lower aggregate costs to the consumer, as well as enable the new media applications that are expected to emerge as local bandwidth becomes available: widespread networked computing,[6] interactive and complex video applications, and high-speed data. Given the stellar growth of the Internet, an LMDS network can arguably be cost-justified in today's market solely on the basis of residential demand for faster data services. Investors wary of investments in local networks in the industrialized markets in Asia should look beyond current market structures into the potential for owning a next generation applications infrastructure.

The greatest potential for LMDS may be in the emerging economies. The reason is the far greater upside in meeting basic service needs -- and doing so with a local network architecture that can meet all foreseeable market needs. It is difficult to imagine a pressing requirement for local broadband communications in China or Indonesia in the near term. But what if local telephone, CATV and data communications networks could all be installed quickly, for a cost equivalent to (or less than) a basic wireline telephone? LMDS technology makes this scenario viable.

Though LMDS has not yet withstood the test of the commercial marketplace, technological acceptance will likely be rapid as awareness of its capability grows.

Today the most formidable challenges lie primarily with political and regulatory approval.
There are a series of major political and regulatory hurdles at the national policy level that must be cleared to make way for LMDS including:

- **Allocation of bandwidth.** Though the 28 GHz frequency range is characteristically unused, governments must coordinate a process to release and assign the spectrum for commercial applications. This process ordinarily involves the approval of radio management control authorities, which may in turn require coordination of military, interior ministry, and public security agencies or other high level government officials.

- **Process for awarding spectrum.** Once spectrum is assigned, a procedure must be established for granting use of the bandwidth to commercial service providers. All countries in the region have precedents for granting narrowband wireless systems, but none for wireless broadband. Broadband has wider policy implications because of the impact on multiple service markets, as well as the complexity of defining the future of public service obligations in basic local services. New Zealand has adopted radical methods for allocating frequencies,[7] while Korea is considering an auction for LMDS. Many countries are watching the US to determine the viability of an auction structure for 28 GHz.[8] Similarly, if spectrum is to be sold or auctioned, the terms for future spectrum allocations must be clearly defined so that investors can reasonably assess the value of acquisitions and the impact of potential competition.

- **Scope of operating license.** Governments may allow new or dominant carriers to provide LMDS services but limit the operating parameters to a tightly defined range. When first considering the technology in 1995, the FCC had intended to restrict LMDS to voice services,[9] a position it has subsequently modified. In Asian markets with tightly defined parameters for competition in local services, a new entrant may, for example, be licensed as a Type II carrier and be restricted to high-speed data or video services.

And, as with any potential alternative access provider,

- **Interconnection.** Without a transparent regulatory agency it is extremely difficult to negotiate and enforce terms of interconnection between carriers.[10]

Unfortunately, in Asia effective regulatory authorities exist only in Hong Kong, Singapore, Australia, New Zealand and Japan. The situation is made especially complicated because few regulators in the region can demonstrate a clear understanding of LMDS.

6. CONCLUSION

LMDS is genuinely a revolutionary technology -- as much for its potential to deliver cost-effective broadband local services as for the role it will play in dissolving the local bandwidth and monopoly bottleneck. LMDS fundamentally redefines the economic argument for increased competition in local services by transforming the notion of value of local access services. In the marketplace, it provides an excellent opportunity for entrepreneurs to prise open local networks, while offering dominant carriers an alternative vehicle for quickly deploying switched broadband capabilities.

The most critical arbiter of market success in the near term will be regulatory change. Historically the local bottleneck has been defined by the technical constraints of the last mile from the service provider to the customer. With LMDS, that bottleneck will shift firmly to the leadership of politicians. The greatest value of LMDS -- the emergence of an effective "third force" for the next generation information architecture -- is possible only with progressive government support.

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Notes

[1] Figures and representative system parameters apply to Texas Instrument's MulTIpoint™ technology.

[2] In Canada, the technology is known as Local Multipoint Communications System (LMCS). On October 20, 1996, Industry Canada awarded three licensees to utilize the 25.35-28.35 GHz for LMCS services: 66 major markets were split between CellularVision Canada Ltd. and Digital Vision Communications. The department also gave licenses for 127 smaller communities to a consortium, RegionalVision Inc.

[3] From the Fourth Notice of Proposed Rulemaking of July 22, 1996, the FCC set aside 850 MHz in the 27.5 to 28.35 GHz range exclusively for LMDS, plus 150 MHz in the 29.1 to 29.25 GHz range, which is to be shared with various LEO satellite operators, notably Teledesic.

[4] Especially digital signal processors and RF management sub-systems relying on gallium arsenide (GaAs) microprocessors, microwave monolithic integrated circuits (MMIC) and advanced epitaxial devices.

[5] For technical and detailed product information, consult a vendor or the following sources: *Telephony*, September 30, 1996 and October 23, 1995; *Electronic Engineering Times*, March 4, 1996; *America's Network*, November 1, 1995; *Multichannel News/Broadband Week*, October 9, 1995.

[6] Consider especially the evolution of the Internet as a connection of "passive" computers to an environment with exponentially greater peer-to-peer links between computers and software applications -- like JAVA, but more comprehensive. See John Brockman, *Digerati: Encounters with the Digital Elite*, (San Francisco: HardWired Books, 1996), especially interviews with W. Daniel Hillis and Esther Dyson.

[7] See Milton Mueller, "New Zealand's Revolution in Spectrum Management," *Information Economics and Policy*, 5 1993.

[8] The October 1996 (PCS) auctions for the F band yielded radically different results that the previous C band auction a year earlier. Per "POP" prices in the F band auction returned between 1/150th to 1/184th the value for identical licenses in major urban markets such as Los Angeles and Phoenix. Source: Terrence McGarty, conference presentation, Columbia University, "The Role of Wireless Communications in Delivering Universal Service", October 20, 1996.

[9] Bruce Egan, "The Economics of the Wireless Local Loop", Columbia University, October 20, 1996.

[10] China Unicom, for example, has begun building its wireline trunk and local telephony network without an interconnection agreement with China Telecom or the Ministry of Posts and Telecommunications.

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A User-Driven Approach To Telecommunication Policy Development

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1. ABSTRACT

Most telecommunication policies are primarily designed to foster competition among telecommunications providers. The fact that tension is growing between those who believe that competition will lead to greater decentralization and global harmony and those who argue that its benefits and disadvantages are not distributed equally indicates that the real question is not whether sufficient competition exists within a given market, but whether the infrastructure meets the real needs of both businesses and individuals. We address this issue through the use of a case study, which identifies *who* accesses *what* services at *what* cost. A brief discussion of policy changes taking place in Venezuela, Spain and the U.S. serves to situate these findings within a global context for the purpose of developing alternative strategies and solutions.

2. INTRODUCTION

As government agencies around the world continue to deregulate telecommunications providers, telephone and cable companies, computer makers, and content providers (film studios, publishers, on-line services) are repositioning themselves in an effort to penetrate new markets; however, each of these groups has different technologies and points of view to promote (1). Moreover, governments assume that in a deregulated marketplace any new information delivery systems will be privately built, owned and operated. Therefore, whoever builds the "information highways" of the future will largely determine how they work and how they will be used (2). If this is truly the case, the tension which has already surfaced between those who believe competition will result in decentralization, empowerment, and global harmony and those who argue that any new technology has benefits and disadvantages which are not distributed equally will only increase. The fact that this tension exists indicates that, perhaps, policy makers are not asking the right questions. Instead of asking whether or not sufficient competition exists within a given market, they should be asking *who* will have access to these services and *what* will they find there. After all, "being linked to everybody and everything in the world won't do much good if you can't use the system or locate the services you need—or if there's no data on line that you care about" (3).

These issues are examined within the context of recent policy developments in the U.S., Venezuela and Spain. These countries were chosen because of their dissimilar cultural, political and economic conditions, but similar telecommunication policy philosophies. In this study the authors assume that increasing channel capacity and government deregulation are blurring the boundaries between point-to-point telecommunications and mass media (print, radio and television) (4). Therefore, the old model of the public as audience or receivers of information must be discarded if telecommunications planning is to move ahead. Instead, "industry and government . . . need to envision themselves as electronic networkers who bring people together" (5). This approach would not only facilitate the development of telecommunications policies that are culturally sensitive, but also economically sound for customers and providers alike. Issues involving technology and competition would not be dismissed out of hand using this approach, but rather, would form an essential part of any integrated user-driven policy.

3. ECONOMIC-DRIVEN POLICIES IN THE U.S.

In 1996 the U.S. Congress passed a new telecommunications act. Two sectors of the telecommunications industry have been fundamentally affected by this legislation—those industries which rely on access to the radio-frequency spectrum and local telephone companies. A brief look at changes in spectrum allocation policies and the increasing aggressiveness of local phone companies provides a reference point for an analysis of the trends resulting from an economically driven telecommunications policy.

3.1 THE R-F SPECTRUM MARKET PLACE

As Professor Ryszard G. Struzak (6) points out:

> . . . current [spectrum allocation] practices based on the administrative and service separation philosophy are inherited from the first radio conferences when radio was mainly a state monopoly and access to the spectrum was practically free. In the meantime the

> world has changed. The state monopoly is being abandoned and the importance of the private sector (especially large, non-governmental, multi-national corporations) is increasing (7).

Nowhere is this paradigm shift more noticeable in the U.S. than in the allocation of radio-frequency (r-f) spectrum space. Until recently the government, through the Federal Communications Commission (FCC), allocated portions of the spectrum to various services through lotteries, competitive applications, or other regulatory processes. Now, the government's approach to spectrum allocation is clearly economically driven. One example is the spectrum auction. Conducted by the FCC, the first auction in the U.S. in 1994 raised approximately US $650 million. Another auction held in 1995 raised another US $7.74 billion (8). The cost of "buying" spectrum space is not uniform, however. In large cities like Los Angeles spectrum space costs much more per channel than in Montana, for example. But regardless of the geographic location, any up-front costs to the telecommunications providers are eventually passed along to the end user.

3.2 THE LAND-LINE MARKETPLACE

Located in rural, southwestern Virginia, Blacksburg is the home of the Blacksburg Electronic Village™ (BEV), a joint venture between Bell Atlantic and Virginia Polytech Institute and State University (Virginia Tech). The community served by this project is quite unique. For instance, more than 50 percent of Blacksburg's residents have personal computers, 54 percent own more than one computer and 48 percent indicate that additional users work with their computers. More than 1,000 homes, five apartment buildings, and 60 businesses are connected to BEV for a total of approximately 9,000 users. Over 8,300 people at Virginia Tech as well as public schools, the public library, and the town government also have access to the network (9).

3.2.1 BEV USER DEMOGRAPHICS

During 1994, four thousand questionnaires were mailed out in BEV newsletters and 332 people responded for a return rate of 8.3 percent. A similar survey on a smaller scale was conducted by the Blacksburg Public Library in April 1994. These surveys were designed to collect information about users' computer experience, network access and demographics. This approach was deliberately undertaken in order to compare the two populations—library Internet users and users who purchased their own access through BEV. A summary of some of this data is presented in the following tables.

Table 1.—Comparison of library users to other BEV users based on household income

Personal Income	Library Users	Other BEV Users
Below $10,000	30.3 %	17.6 %
$10,001 - $20,000	16.1 %	14.6 %
$20,001 - $30,000	12.5 %	10.2 %
$30,001 - $40,000	8.9 %	11.2 %
$40,001 - $50,000	7.1 %	12.2 %
$50,001 - $60,000	10.7 %	9.7 %
$60,001 - $70,000	3.6 %	5.7 %
$70,001 - $80,000	7.1 %	4.2 %
$80,001 - $90,000	1.8 %	2.5 %
$90,001 - $100,000	0.0 %	2.7 %
$100,001 - $150,000	1.8 %	6.9 %
$150,001 - $200,000	0.0 %	1.2 %
Above $200,000	0.0 %	1.2 %

Table 2.—Primary reasons for using BEV

Uses	Particular Visit	Overall
Educational	17.9 %	25.0 %
Business/Work Related	9.0 %	6.3 %
Personal Needs/ Research	25.4 %	18.8 %
Personal Leisure/ Entertainment	23.9 %	31.3 %
Personal Communications	19.4 %	15.6 %
Other Reasons	4.5 %	3.1 %

3.2.2 COSTS OF IMPLEMENTATION AND CONNECTION FEES

To provide ISDN, Ethernet and other value-added services, Bell Atlantic initially invested more than US $6 million in the project. This investment included the installation of 42 miles of fiber-optic cable and a digital electronic switching center, which allows voice, data and full-motion video to pass simultaneously over the same lines. In addition, the company also donated the use of a broadband T-1 data line for a one-year trial period to the Montgomery-Floyd Regional Library. Xyplex Inc. then donated a 20-port hub/router with a Wide-Area Network (WAN) card, which was used by the library to connect seven Ethernet workstations to the Virginia Tech network through the T-1 line. Library patrons use these workstations to gain "free" access to e-mail and the Internet. During the one-year trial period, network costs to consumers were as follows:

One-time registration fee:	$6.00
High speed modem:	$8.60/month
Low speed modem:	$5.00/month
ISDN:	$8.60/month
Off-campus Ethernet:	$5.00/month

Public access terminals in the Blacksburg Public Library are available to all members of the community without charge (10).

To provide free access to members of the public who could not afford the hardware and monthly service fees, the Montgomery-Floyd Regional Library system purchased over $45,000 of computer hardware and software, $4,000 worth of supplies, $600 in Ethernet connections, over $48,000 in salaries and benefits for staffing and training, and now that the trial period is over, the library will have to begin paying $425 per month to keep its broadband T-1 line—a heavy burden when the annual local library budget is a mere $1.1 million for the three libraries in the regional system.

On a more personal level, after 1 July 1996 Virginia Tech removed anyone not associated with the university from its subsidized modem pool. If these users wanted to maintain their Internet connections, they had to sign up with commercial Internet service providers. In some cases, the privilege of fast Ethernet service skyrocketed from US $5.00 per month as a subsidized service to US $40 per month in the commercial marketplace (11). Undoubtedly, the higher figure more closely represents the cost of providing this type of high-speed connection to the customer, but it also severely limits the potential customer pool.

3.3.3 OUTCOMES

The data in Tables 1 and 2 seem to support the contention that *we suffer from a failure to communicate*—at least among large segments of the population. "Women, children, old people, poor people and the genuinely blind are still very much under represented in the world of cyberspace compared to the physical world" (12). If these problems exist in the highly educated, computer-literate, affluent world of BEV, what then are the implications for less-developed countries and the rural and poor areas of the core industrialized societies? Other studies indicate that these problems exist elsewhere as well:

> [For instance,] mostly missing [on the Internet] are the illiterate and the continent of Africa. [Instead], most of cyberspace is populated by white males under 50 with plenty of computer time, great typing skills, high math SATs [Scholastic Aptitude Tests], strongly held opinions on just about everything, and an excruciating face-to-face shyness, especially with the opposite sex (13).

Clearly, any telecommunications policy must address these challenges so that the basic needs of society are met. Policies must make sure that new technologies are "ubiquitous, affordable, easy to use, secure, multipurpose, information rich, and open, and, if it is to be economically viable, service providers have to be able to bill customers for the time they spend on the network or the data they use" (14).

4. THE CHANGING EUROPEAN MARKET

As late as 1984 European telecommunications was dominated by state-owned companies. At that time, many members of the European Union (EU) realized that, in order to become competitive, they needed to break up state-run monopolies and privatize the market. Initially, they focused on three areas: (1) technical interfaces, (2) usage conditions and (3) tariffs. The European Council issued specific directives for the liberalization of all telecommunications services with the exception of basic telephone services. It required EU members to withdraw their exclusive rights, to issue future licenses under nondiscriminatory conditions, and to ensure full transparency between government and the Telecommunication Administrations (TAs) relations as well as between the commercial and regulatory functions of the sector (15). Despite all of these legal efforts, liberalization has taken place slowly due to the reticence of some monopolistic corporations.

Although a common and open market was established for the (then) twelve member countries of the EU in 1992, phone tariffs, in particular, remained unequal and expensive within the European countries, and customers were faced with long delays in obtaining basic services (16). As a result, in the *1992 Review of the Telecommunications Services Sector*, the Commission adopted a middle-of-the-road policy which resulted in the partial liberalization of voice telephone services within member states (17).

4.1 SPAIN AND TELEFÓNICA

The greatest roadblock facing the EU in implementing the new telecommunications law is the wide range of economic conditions found among its members (18). Spain, for example, is somewhere in the middle. When it entered the European Community in 1986, Telefónica (a 32 percent state-owned telephone company) started to convert from analog to digital technology. It also decided to expand its overseas operations to several Latin American countries (Argentina, Chile, Perú, Venezuela and Columbia) (19). By the end of 1995 Telefónica reported that it had installed over 8.4 million phone lines, had 460,000 mobile service customers and 238,000 cable television subscribers in Latin America, even though the Latin America market constitutes only 20 percent of the company's total revenues(20). Furthermore, its frenetic expansion abroad does not correspond to its activity in Spain, where there are only 37 lines installed per 100 residents, compared with 51 installed lines per 100 in the U.S. and an average of 47 lines per 100 in Europe (21).

4.1.1 PACE OF DEREGULATION

The Spanish government kept its monopoly on mobile services until 1994, despite the initial attempt by the EU to liberalize this type of service in 1992 (22). As a consequence of a change in government, however, the telecommunications sector is moving in a new direction. The Spanish phone company is beginning to cut jobs, rebalance call tariffs and strengthen international alliances and investments as part of a restructuring process aimed at the creation of a more competitive business environment (23). Telefónica became a member of the pan-European telecom consortium, Unisource, which was formed by PTT Telecom Netherlands, Swiss Telecom PTT and Swedish Tella (24). At the same time the Spanish government is selling off its shares of Telefónica. In the fall of 1995 it sold 12 percent of its Telefónica property (US $1.46 billion), declaring that its purpose was to reduce its [the government's] stake to a minimum before Spain's telecom sector is fully liberalized (25).

4.1.2 BUSINESS OPPORTUNITIES

All of these forays into new markets and new investments have created suspicions in the European Commission about Telefónica's intentions (26). For example, the EU does not like the idea of Telefónica's participation in Unisource while the Spanish government is petitioning for a five-year period of transition before fully deregulating its telecommunications sector (27). According to the Commission, the Spanish government would like to be able to compete abroad while keeping its borders closed to other providers (28). Therefore, Spain is faced with a dilemma as the liberalization deadline approaches in 1998: Should it compete with the major telecom businesses or protect the Spanish market until consolidation of the Spanish telecommunications sector in the year 2003?

Due to strong pressure from the European Commission, it appears that the government has opted to go ahead and open its domestic telecommunication market at the end of 1998 (29). The government also announced on 24 July 1996 that it intends to create a Committee of the Telecommunications Market, which will function along the lines of the U.S. Federal Communications Commission (30). It also plans to issue a second license for basic telephone services at the beginning of 1997 (31). Along with the drafting of a new telecommunications law, Spain seems to be moving in step with most of the other EU member countries toward a more deregulated marketplace.

4.2 FUTURE POLICY DEVELOPMENTS AND POSSIBLE CONSEQUENCES

As more and more European governments move towards complying with the EU's telecommunications laws and policies, the more competitive their businesses will become in relation to U.S. firms. This competition will undoubtedly result in lower tariffs and a unified European telecommunications infrastructure (32). These competitive advantages beg the question of individual consumer needs, however, especially when cultural barriers, such as language, are taken into consideration. After examining how these issues are being addressed in Latin America, we will return to this problem and propose some strategic methods of dealing with it from a global perspective.

5. THE CHANGING LATIN AMERICAN MARKET: VENEZUELA

When the American telephone giant AT&T reached an agreement with the Venezuelan telephone monopoly more than a decade ago, few Latin American governments foresaw the radical changes that would take place within the next few years (33). The telecommunications sector has developed faster than other sectors of the Venezuelan economy, with an average annual investment of US $1.1 billion between 1992 and 1993 and US $500 million in 1994 (CONAPRI, 1996). This investment was primarily driven by the privatization of the state-owned telephone company, *Compañía Anónima Nacional de Teléfonos de Venezuela*, otherwise known as CANTV.

5.1 MOVEMENT TOWARD DEREGULATION

Until 1991 Venezuela lagged behind many Latin American countries in terms of availability of value-added services. Amid growing concerns about CANTV's unwillingness to upgrade the infrastructure, the company was sold to a consortium led by General Telephones Exchange (GTE) (34). On 2 August 1996 the Venezuelan Congress authorized the sale of 49 percent of CANTV's state-owned stocks as part of its privatization policy, which was established in the Privatization Law. At the same time, CANTV's employees and retirees were assigned somewhere between 11 and 20 percent of the company's ownership. As a consequence, the state is now chiefly a regulator of the telecommunications industry, rather than a principal player.

The current telecommunication law dates back to 1940, with modifications added by the Law of 1995 (35). While the Telecommunications Law reserves control of all telecommunications services for the state, it does set up a concession system whereby participation by the private sector is permitted. The only services subject to limitations on investment are radio and television (except for investments from the other Andean Pact countries: Bolivia, Columbia, Ecuador and Perú). In fact, there are no limitations on foreign investment in telecommunications other than those indicated in the legislation on Foreign Investment.

5.2 UPDATING THE LEGAL FRAMEWORK

In 1991 CONATEL was created as a General Sectoral Directorate under the Ministry of Transport and Communication (MTC). This was probably the most important step in updating Venezuela's legal framework. Its primary purpose is to promote the introduction of new services. CONATEL's mandate includes planning, directing, supervising and regulating telecommunications services through the promotion of investment and technological innovation. In an interview with *Business Venezuela* Jose Soriano, head of CONATEL (*Consejo Nacional de Telecomunicaciones*), argues that telecommunications regulation should be separated from transportation regulation because Venezuela needs a technically proficient, flexible ruling body with little bureaucracy to respond to the challenges of continuously changing technologies. Proposed legislation seems to address Soriano's concerns by limiting the role of the government to one of regulator or controller.

5.3 TARGETS FOR EXPANSION

Recently, CONATEL has begun promoting the Third Tri-Annual Telecommunications Plan. This plan calls for the implementation of seven new services over a three-year period. Large-scale private investment as well as a commitment from the Venezuelan government to help develop the telecommunications sector play important roles in CONATEL's overall strategy. According to a conservative scenario, these seven services would attract an accumulated investment of US $9.1 billion by the year 2000 (CONAPRI, 1996).

One of the areas singled out for development is the mobile phone market. The resounding success of cellular telephony reveals the extent of the demand for this type of service in Venezuela. Venezuela has one of the highest per capita cellular phone usage rates in South America (36). In addition to promoting continued growth in the cellular phone sector, the introduction of Personal Communication Services (PCS) and Inmarsat (37) has been given a high priority by the authorities. The government hopes that these services will promote the integration of trunking, community, paging and cellular telephone services. To that end, it will open a third cellular operating company.

CANTV also announced its intentions to go into the cable television business, but the 12 cable operators that comprise CABLETEL (the Venezuelan subscription TV company) protested to the MTC. They argue that CANTV represents a threat to their government-granted rights as a cable TV provider, because CANTV already has a superior infrastructure in place. They cite the current telecommunications law, which states that only firms totally controlled by domestic capital can broadcast over the air. Only 71 percent of CANTV is held domestically. On the other hand, CONATEL ruled that independent operators can begin offering phone services in the year 2000, the year CANTV's phone monopoly ends. According to CABLETEL figures, thirty to forty percent of Venezuelan households can afford cable (38). These projections translate to approximately 6 to 7 million people.

Soriano states that the Venezuelan government is in favor of establishing a telecommunications services market within the Andean Pact and the Group of Three (G-3) for the sole purpose of turning Venezuela into a regional telecommunications center (39). It plans to accomplish this goal by inviting telecommunications equipment companies to establish manufacturing plants in Venezuela. Soriano says that this commercial strategy would provide the Venezuelan people with telecommunications, telematic and audiovisual media, thereby promoting the incorporation of telecommunications into Venezuelan society (40).

5.4 FUTURE POLICY DEVELOPMENTS AND POSSIBLE CONSEQUENCES

As these services are introduced during 1996, specific action by the regulatory body will be necessary to develop this sector. These actions include, but are not limited to: (1) implementation of the Spectrum Controller System (SICOTOR); (2) introduction of advanced interactive video technology; (3) promotion of updated technology for beeper, community and trunking services; (4) promotion of the program "Telematics for Everyone"; (5) development of a plan to train human resources for the sector; (6) development of other general plans, such as opening new markets for services at the level of the Andean Pact, Group of Three (G-3) and Brazil; and (7) approval of the new Telecommunications Law.

The Venezuelan government realizes that efficient operation of the telecommunications sector is the cornerstone for attracting foreign investment, increasing international trade, expanding domestic organizations and enterprises. If these goals are met, the government believes that political stability will be maintained. In addition, as large-scale telecommunications projects require regional and international cooperation, the foundation will be laid for greater integration of other sectors of the economy among the Andean Pact trading partners. But, the questions posed at the beginning of this paper must be raised again: (1) *Who* will have access to these services? and *What* will they find there?

6. A USER-DRIVEN APPROACH

The answer to these questions depends less on technology than on corporate decisions to pursue certain areas of economic development—in this case telecommunications. Having examined such areas as governmental policy-making, foreign competition, and economic considerations, one can begin to see certain commonalities among nations and groups that continually affect the deployment of new technologies. Furthermore, simply providing low-cost, technologically advanced, efficient services, in certain profitable market areas is not enough to maintain a competitive edge.

6.1 PAST APPROACHES

There is a natural tendency for any country attempting to deploy an advanced telecommunications infrastructure to be hampered by the preconceived notion that existing technologies must be protected. Most regulatory agencies try to formulate rules governing new technologies based on past practices and reactive rule-making procedures. For example, in the U.S. the FCC still categorizes technological systems by application (broadcast, common carrier, cable, etc.) even though most technologies, and certainly digital technologies, make these distinctions irrelevant. Furthermore, most industries and associations representing those industries lobby for unrestrained trade and competition—until they find themselves being undercut by competitors. This philosophy also carries over to research and development (R&D). Many firms actively seek out public funds for research, yet decry public control of the infrastructure as over-burdensome and anti-competitive. Finally, a global capitalist economic system generates a number of forces which can no longer be controlled at a national level. Protective tariffs, unique "standards," and subsidization of certain businesses to protect a state's dominance no longer work in a world in which multinational corporations are linked by instantaneous communications.

6.2 CONCERNS, RECOMMENDATIONS AND CONCLUSIONS

Nations wishing to remain competitive must develop better ways to develop problem-identifying, problem-solving workers and better ways of linking them together. These goals can only be achieved by selecting the right combination of technologies for a given situation.

6.2.1 AVAILABLE TECHNOLOGIES

Today, the principal forms of delivering information around the world include twisted-pair copper wires, fiber optics, terrestrial broadcasting and two-way radios (including cellular and "Sky" phones), coaxial cable and satellites. All of these technologies can handle digital information. So it makes no difference, from a transmission standpoint, whether the information originates from radio, TV, supercomputers or anything else. Therefore, the ideal approach would be to allocate electro-magnetic spectrum bandwidth based on transmission efficiency, rather than on pre-existing service subbands. Once the spectrum is assigned using this criterion, nations could then develop an infrastructure based on community needs. For example, remote areas may need satellite coverage, whereas cities could be served by fiber. Low-data-rate users could benefit from packet radio and low-cost receivers.

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6.2.2 CONCERNS

Forming new technological policies is a formidable task. On the one hand individual users' needs must be addressed, while on the other, the needs of business must also be acknowledged. In many cases the goals of these two groups may be at odds with one another. Any telecommunications policy must address the concerns of both groups. In the case of business "standards for connectivity and interoperability must be adopted, a balance must be reached between competitive and regulatory forces, the question of closed or open access must be addressed, there must be protection of rights, research must be funded, the media must be transparent to the user, and the role of the Internet must be defined—is it for research or for profit?" (41)

From the standpoint of individual users, policies must be developed which ease existing regulations on cable and the telephone companies, yet continue to ensure some form of universal access to the information infrastructure. In the past universal service in the U.S. has relied on cross-subsidizations to fund service using income from higher-margin clients such as businesses and long-distance customers. If we now define universal service to include access to local and global information networks, the added costs of hardware and support services could limit potential users and disenfranchise even more groups(42). In the end whoever pays for such services will dictate who benefits. The private sector isn't going to be willing to invest in information services from which it can't profit. This could lead to the problem of access that is priced beyond the range of the people who need it most (43).

6.2.3 RECOMMENDATIONS

Based on the results of this study, the following recommendations for designing future telecommunications systems are proposed:

1. National and state policies which reflect a clear and elevating goal must be instituted; values and expectations for individuals as well as groups must be clearly communicated within this framework.
2. Policies should recognize current and future needs of the population in relation to the creation and evolution of technologies, including predictions that integrate historical factors into the present possibilities and future potentialities.
3. Development of telecommunications technology must be fostered within a framework which supports and encourages individual and corporate initiative while reflecting a responsibility to guarantee access to basic information services by all citizens, irrespective of background, training, or technological expertise.
4. Policies which support innovation and experimentation are necessary for these goals to become reality in the 21st century (44).

6.2.4 CONCLUSIONS

Ultimately, there is a need to focus efforts on achieving a better balance for worldwide access to information and communications. The primary question seems to be "Can the private sector be convinced that it is in their best interests to assist in the expansion of the Global Information Infrastructure into low-demand regions?" (45) Perhaps more realistically one can focus the various individual country requirements into a meaningful market. If one could add together the end-user requirements for existing and new services in agriculture, education, health, disaster communication, government operations and the industrial sector—especially tourism—one may begin to see an attractive market.

As we move closer to the vision of the free-flowing, freely accessible electronic information stream, we can see trends (clearly shown in the BEV tables focusing on income and use) that are products of many complex social forces. Two of the most important trends are (1) a growing preference for entertainment over knowledge and (2) a widening polarization along social class lines of entertainment consumers and knowledge consumers (46). One thing that most people can agree on is the fact that universal service no longer means the universal deployment of a single technology—and the rapid pace of innovation makes the old concept of universal deployment impractical. Different technologies will be used in each town and neighborhood. Even next-door neighbors may be served in different ways. So we have to separate the regulation of information services from the technologies by which they are distributed (47).

The utopian vision of developing a working telecommunications infrastructure is just that—utopian. In reality established services will continue to lobby for protection, and government officials will continue to regulate the industry based on preconceived and past practices. Nevertheless, certain actions can be taken now to improve the overall situation. First, everyone must recognize that no one telecommunications infrastructure will work in all cases. Cultural considerations and needs ultimately decide what a society will or will not accept.

advertising and marketing executives' beliefs to the contrary. Second, governing bodies must realize that the shift from analog to digital information delivery systems is giving us the opportunity to view information applications from a new perspective. We can use this opportunity to break away from our rigid approaches to spectrum planning.

If we can accomplish this feat, we can then explore ways in which to integrate various digital technologies into seamless telecommunications infrastructures. Our goal is to organize the market in such a way that it will motivate the problem solvers or "symbolic analysts" (48) to discover new ways of helping society while inflicting the least amount of harm on our global environment.

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Deregulation of China's Telecom Industry: the Case of China Unicom, Inc.

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China Unicom, a new rival company to China's state monopoly carrier, has been a target for foreign investment since its formation in 1993. A combination of bureaucratic jealousy and the company's own mismanagement have frustrated its joint venture operating company partners. Unicom has had limited success in creating a mobile phone network in major Chinese cites, and planned reforms in China may give the company a signicant boost for future growth.

For the past three years, the Chinese government has been promoting China Unicom as a potential rival to the state monopoly run by the Ministry of Posts and Telecommunications (MPT). With a wink to foreign telecom operators, the company has implied financial cooperation with the company will mean a future cut of ever growing phone use receipts. As the only investment game in town, Unicom has attracted many suitors. But is the fledgling phone company China's second carrier, or merely a pawn in the fierce ministerial rivalry of China's industrial complex?

The story of Unicom (a.k.a. Liantong) illustrates the venality of Chinese bureaucratic politics operating in one of the most lucrative of industrial sectors. But foreign telecommunications operating companies seem to have been unwitting victims of personal power plays and questionable operating practices.

Unicom's birth

As with many elements of China's post-Mao reforms, change in the telecom sector was inspired by characteristics of foreign market economies. The ideas of industrial competition inspiring enhanced efficiency and government functioning as a regulator filtered slowly into discussions of industrial policy reform.

By 1988, the Chinese Academy of Sciences, with backing from the State Commission for Economic Restructuring, was sending scholars to the US to find how the FCC managed the telecommunications landscape following the break-up of AT&T. The investigators particularly noted the effects of separate government regulation and private corporate operation.

The clamp down following June, 1989 student demonstrations in Beijing took telecom reform off the political agenda, as all major changes were temporarily frozen. The MPT grasp on both operations and regulatory power, however, was again challenged in 1992, as the country began a new wave of economic and political change. Some international pressure to break the state monopoly on telecommunications came from the World Bank, a key source of revenue, which naturally encouraged the broadening of market forces.

The Bank also wanted to see the spread of telecommunications to rural areas in China, parts of the country which the MPT itself was less eager to develop. These areas were more costly to connect, and lower standards of living necessitated subsidies to customers less able to pay high connection charges and monthly fees.

Early noises for reform came from the Ministry of Electronics Industry, which had manufactured equipment for the industry but now wanted a piece of the operations pie. New minister Hu Qili, resurrected from a post-1989 purge of the communist party politburo, led the battle to create a rival to MPT operations control. Eventually, the ministries of Electric Power Industry, Railways, and 13 other partners joined the MEI to officially open China United Telecommunications Corporation (usually called Unicom) in July, 1994. MEI, lacking its own telecommunication lines or wireless systems, favored the alliance with the Power and Railway ministries, both of which had substantial private telecommunications networks. (The Chinese military, however, which also had its own wireless communication system, was absent from the list of shareholders.) The Unicom members together represented a potentially powerful array of stakeholders meant to challenge the MPT monopoly.

The nascent company's goals were ambitious: by the year 2000, the company wanted to hold 10 percent of both domestic and long-distance service in China, and take 30 percent of the country's mobile communications market. Unicom's charter encouraged it to spread services to areas where the public networks could not reach, or where there existed severe shortages of services.

Problems of Leadership, Corporate Structure, and Finance

The disparate share-holding structure immediately created problems for Unicom. According to the principle of separating state and corporate management, the board chairman of Unicom should not have a base in the MEI or any of the other Unicom partners.

Zhao Weichen, who had been a vice minister of the State Economic Commission and vice governor of Guangxi province, seems to have won the top job at the company by default.

The first choice for the second-ranking post at the company was Zhang Shukui, a former vice governor of Guizhou province and an experienced electrical engineer. Zhang, however, was removed from Unicom's preparatory team even before the official establishment of the corporation, apparently because Zhao feared he would present a leadership challenge. In a similar way, Liao Youming, a former president of the China Electronics Corporation Group and an assistant to vice premier Zou Jiahua was released 3 days before his official appointment to the post. Despite pressure from the shareholders, Zhao managed to run Unicom as his own personal preserve and keep any potential rivals at bay during its early years of development. His autocratic behavior continued even after Li Huifen, former vice mayor of Tianjin and former radio corporation engineer, assumed the general manager position in July, 1995.

The MPT's prohibition on forming joint ventures with any foreign-related entity meant Unicom received lavish attention from Western operators seeking entrée to the China market. Zhao exploited the foreign interest, and was plied with constant offers of elaborate banquets sponsored by foreign suitors and all-expense paid travel around the globe. He apparently had little time left to devote to the company's management or development.

In his desire for control, however, Zhao orchestrated the proliferation of Unicom "branches" as the three ministries, other original shareholders, and provincial and municipal entities targeted sites across the nation for myriad projects, most of which planned to offer GSM (the Global System for Mobile standard) mobile phone service.

By mid-1996, there were more than 50 of these organizations with operations projected for 22 cities.

None of the branches was allowed to be a legal entity, and each therefore required approval from central headquarters to form any kind of joint venture. Frustrated shareholders struck out on their own to make deals, with CITIC and MEI among those forming wholly owned telecom subsidiaries; lacking a license, however, resulting contracts were subject to final approval.

A further reason for Zhao's manipulation of the company's structure was the lack of a capital base at the company's headquarters. The three ministerial shareholders gave only RMB 100 million (US$12 million) each, and the other 13 members of the company contributed RMB 80 million (US$ 9.6 million) a piece. The central government gave no other financial support, though the State Council did allocate 6 MHz of radio frequency in the 900 MHz spectrum band to the new company; this was more than the 4 MHz granted the MPT for its own GSM network. With little money of his own to hand out, Zhao wanted tight procedural control over the partners in the company. Thus, once foreign investors arrived to offer an alternative capital source, Unicom helped shape an investment method that conformed to the centrally-manipulated branch model.

The Foreign Factor

The key enticement for foreign firms to court Unicom was the lack of opportunity to team up with MPT's nationwide operational arm, China Telecom, or the provincial telecom authorities (PTAs). Foreign operations firms who approached the MPT initially were rebuffed; one company representative felt the ministry simply did not recognize the need for any foreign involvement, given the rapid increase in new customers connecting to the near monopoly carrier's lines.

All of the contracts the Unicom central office and the branches arranged with foreign investors were signed under a unique joint venture scheme called "F-C-C," which stood for "Foreign-Chinese-Chinese." To mid-1996, the Chinese government prohibited direct foreign involvement in telecom operations (ostensibly for national security reasons), but the F-C-C scheme allowed a separate Sino-foreign joint venture (F-C) to team with Unicom (the second "C") to establish an operational entity.

The foreign side was denied management or other oversight duties, and typically was asked to contribute only capital. In practice, though, the lack of Unicom experience inevitably inspired it to turn to the foreign carriers for informal advice on network design, equipment procurement, and other management issues. Chinese regulations barred direct revenue sharing, but the foreign company was to receive (through its joint venture) a portion of the operation returns for its seemingly intangible contributions to the network development. The complex reimbursement scheme meant increased risk for early investors in the sector. Despite these restrictions, however, foreign companies believed in an eventual liberalization of the China telecommunications market, and felt early joint ventures would set the groundwork for later more extensive and, perhaps, lucrative, operations in China.

Though Unicom was able to secure many interested partners, the level of satisfaction with the company was low. Some chafed at the inability to participate in operations, pointing out that Unicom's billing systems, equipment maintenance, and other service functions were sorely lacking in the four GSM mobile phone sites (Beijing, Shanghai, Guangzhou, and Tianjin) that went into operation in July, 1995. One executive complained that no BOT (Build-Operate-Transfer) schemes existed in the industrial sector; he called the current status "BTT," for "Build, Transfer, Thank you very much."

Still, many of the problems that developed with foreign investors rest squarely with the Unicom management. The case of BellSouth losing a GSM contract for Beijing operations to MasterCall of Thailand, for example, served as a serious warning to other potential future investors. Though details remain sketchy, Unicom apparently violated terms of an exclusive negotiating period with the American company to reach a contract with a company willing to put more cash up front. A reputation for dealing in bad faith is not easily repaired.

The MPT Challenge

Unicom not only faced the problems of suspect management and a fragmented command system; the former monopoly MPT loomed as a major irritant at best, and a potential assassin at worst. From the beginning, the MPT opposed the formation of the new company, and it took several steps to shorten the life span of the infant telecom provider.

Permission for connection to the public network was the MPT's primary weapon. Unicom officials were forced to complete seemingly endless series of forms before they were allowed to hook their customers into the national network. Predatory pricing of mobile handsets also weakened Unicom in 1995, as the ministry was quick to match or beat any attempts to undercut its costs in the markets the new company sought.

Finally, the MPT's biased determination of rates for access to ministry lines (interconnection) was another bureaucratic hurdle to retard Unicom's development. In Shanghai, for example, a ten minute mobile phone call cost the Unicom customer RMB 4.00 (about 50 US cents). Of this, local sources indicated the Shanghai PTA collected 90 percent of the toll, leaving Unicom to receive only about 5 cents for the transaction.

The only hope for Unicom seemed to be a real division of regulatory and operational activities from the MPT conglomerate.

In 1994, the government announced the separation of the Directorate General of Telecommunications (or DGT; later known as China Telecom) from the MPT to be the national system operator; the MPT would be left with regulatory powers. But some observers feel the whole exercise was mere window dressing for international financial organizations calling for liberalization of the industrial sector; through mid-1996, the two entities were still working hand in hand.

Though many foreign observers were holding their breaths for a new telecom law to enforce the separation of regulation and operation, it appeared only a wholesale turnover of personnel in the MPT would establish it as a truly independent regulator. The appearance in late 1995 of a "leading group" of top government officials to examine high technology policy making, one led by vice premier Zou Jiahua and orchestrated by Hu Qili, seemed to indicate the development of the industry might one day lie in hands stronger than those working at the ministerial level.

Unicom's Future

By mid-1996, twelve months after their launch, Unicom's four operational mobile phone networks were collectively serving a mere 35,000 subscribers. Given the multiplicity of problems and challenges Unicom faced, however, the company stood little chance of achieving its early growth targets. By 1996, Unicom's initial goals had become unrealizable dreams, and the company was rapidly falling behind a revitalized MPT communications machine. The company had constructed an unworkable management hierarchy inspiring constant shareholder tensions, had alienated some important foreign investors, and was under constant pressure from manipulative MPT practices.

Several factors did point to some reason for hope. In March, 1996, Yang Changji replaced Zhao Weichen (reportedly removed after he had alienated general manager Li Huifen). Yang was a former vice minister of the economy and trade commission and a leader of Shanghai's Pudong development efforts, and his strategy apparently included a less flamboyant attitude toward foreign investor relations, as well as an emphasis on core projects in China's developed coastal regions. But Yang was himself replaced by former MEI vice minister Liu Jianfeng in July, 1996, and Li Huifen moved to become the company's CEO. The MEI seemed to be asserting more control over the company's top leadership selection.

Perhaps more important, however, were the reputations put at stake in the creation of Unicom. The company's supporters included Hu Qili and vice-premier Zou Jiahua. Zou and vice-premier Wu Bangguo were to lead a special investigation group in 1996 meant to examine all of the problems Unicom had experienced to date. Should Unicom fail, moreover, China would seem to fall back on the old monopoly model (though the military, with its own allocation of frequency in the 800 MHz band, stood to be a wild card in the battle for mobile customers).

New leadership, top-level support, some vested foreign participation, and the radio frequency allocation the company possessed, then, may be the savior for the telecom experiment. If nothing else, the appearance to the world financial community of competition in the sector will keep the company around in some form. Though it probably will not reach its development goals set for the year 2000, Unicom will probably survive to celebrate its sixth birthday that year.

THE IMPACT OF WDM ON THE ASIA-PACIFIC NETWORK

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1. ABSTRACT

Wavelength Division Multiplexing (WDM) is a new technology offering high capacity and efficient networking. It will soon be implemented in the Asia-Pacific region where numerous projects are being discussed and set up. Restoration of these future networks will be possible via the worldwide WDM loop concept.

2. INTRODUCTION

Due to the dramatic increase of Internet users, liberalisation of the telecommunications and globalisation of businesses, the demand in telecommunications bandwidth is growing significantly year after year.

In the meantime, a new technology, Wavelength Division Multiplexing (WDM), is emerging and is going to reshape the submarine networks. It will allow for greater traffic capacity as well as enhanced network capabilities. The Asia-Pacific region is ready to take the full benefits of WDM flexibility, upgradability, easy network restoration and global network planning.

3. FUTURE TRAFFIC

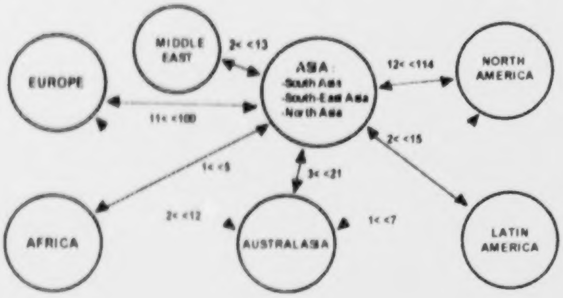
Figure 1 shows the computation of the expected traffic from and to the Asia-Pacific region by the year 2010, millions of minutes being converted to the number of 2.5 Gbit/s signals. It has been assumed that 85000 minutes represent approximately one 64kbit/s stream. The two values that are shown represent the pessimistic and optimistic scenarios.

The values do not take into account the margins necessary for traffic restoration or peak demand periods. To include an allowance for full traffic restoration would lead to almost a doubling of these values. To that extent, the figures can be seen as conservative.

The comparison between these figures and the 1993 figures shows that the traffic between Asia and North America (excluding Australasia) is expected to multiply by a factor of 10 (pessimistic estimate) to more than 100 (optimistic estimate).

The inter-Asia traffic expectation growth is known as being even greater. To give an idea, the traffic growth between South East Asia and North Asia is expected to multiply by a factor between 50 and 200 from year 1993 to year 2010.

FIGURE 1. TRAFFIC GROWTH EXPECTATIONS
(Year 2010 expected number of 2.5 Gbit/s streams (pessimistic and optimistic)-Source: ITU/CSMG)



To match this future demand, existing systems with a capacity as low as 560 Mbit/s are obviously insufficient. For these reasons, only 5 Gbit/s systems and future WDM systems can be considered. Furthermore, with satellites unable to provide such high capacity, traffic via submarine systems is the only option.

By the end of 1996, only one system (TPC5) will link Asia and North-America at a bit rate above the Gigabit boundary. Looking at the traffic expectations, in particular when considering network restoration, new high capacity links will clearly have to be installed within a few years. Similar statements can be made in other parts of the world, emphasizing the welcome to new high capacity technologies such as WDM.

4. WDM TECHNOLOGY

The WDM principle is to multiplex several carrier frequencies (wavelengths) onto a single fibre. Each wavelength carries typically 2.5 Gbit/s of information. The number of wavelengths that can be multiplexed together ranges from two to eight (even more in the future). This leads to 8 * 2.5 Gbit/s = 20 Gbit/s of capacity, which is four times greater than the previous 5 Gbit/s generation.

Apart from increasing the data capacity on a single fibre, WDM offers networking facilities by means of Add-Drop capabilities in intermediate undersea WDM Branching Units.

FIGURE 2. WDM PRINCIPLE

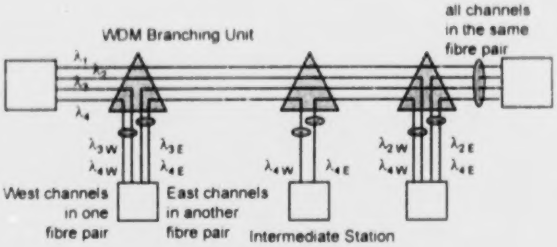


Figure 2 illustrates this principle: at each intermediate station, one or more wavelengths are dropped and added from and to the main trunk towards the concerned stations. The main benefits of these filtering undersea WDM Branching Units are considered hereafter:

*Only the required intermediate traffic is dropped and/or added, the main traffic remaining on the trunk. Hence at the intermediate stations, the equipment is dimensioned to multiplex and demultiplex the required added and/or dropped traffic only. No transit traffic is needed at these points.

*In the case of a cable break in the spur, all the main traffic on the trunk is maintained. The failure affects only the intermediate station.

*It allows network implementation in successive steps: providing that a WDM Branching Unit is put undersea, an intermediate node can be equipped at a later stage of the network implementation as the traffic demand increases at that particular node.

*Moreover, WDM technology offers the possibility to upgrade the traffic capacity starting with one or two wavelengths up to eight as needs arise without the need to alter the as-laid cable system.

5. NETWORKS' NEW SOLUTIONS

As technology offers more bandwidth capacity, more services are available and more complex the network design is. The operators' evolving needs consequently lead to the introduction of new submarine network concepts:

*Single point-to-point links are less and less applicable. A network approach is required.

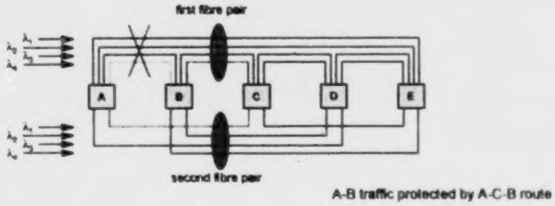
*Integrated networking is more in demand: a submarine system is always connected to a terrestrial network and sometimes to a microwave network. Operators want overall solutions with unique network management for their terrestrial and submarine networks.

*Network protection has superseded equipment protection.

*Network flexibility involves easy network evolution and reconfiguration as well as capacity upgradability.

Using basic network topologies (string, ring, mesh), WDM offers new network approaches. Figure 3 shows one possible configuration of a regional mesh network, where two fibre pairs carrying four wavelengths each allow rerouting around any single fault on a particular path.

FIGURE 3. WDM REGIONAL MESH NETWORK



Equipment protection is not required any more since the network configuration provides the protection itself. In this scheme, a traffic interruption between stations A and B, is automatically restored using the second fibre pair and station C as an intermediate station between A and B.

This topology as well as numerous alternate network architectures show that WDM can provide the following:

•Full mesh connection by wavelength,

•Easy wavelength allocation and reallocation adapted to the changing traffic (in association with SDH equipment such as Add-Drop Multiplexers and Cross-Connects),

•Ability to allocate dedicated wavelengths between two particular nodes and as a consequence to protect sovereignty,

•Avoidance of equipment protection because protection is inherent in the network capabilities.

•Merging of domestic and international traffic on the same fibre by allocating different wavelengths to the two types of traffic.

6. EXAMPLES OF WDM PROJECTS IN THE ASIA-PACIFIC REGION

The advent of WDM and its attractiveness to customers has enabled Alcatel Submarine Networks to offer WDM solutions on all new projects with a Ready For Service date being as close as the second half of 1998.

Hereafter are described some of the potential projects that can benefit from this technology.

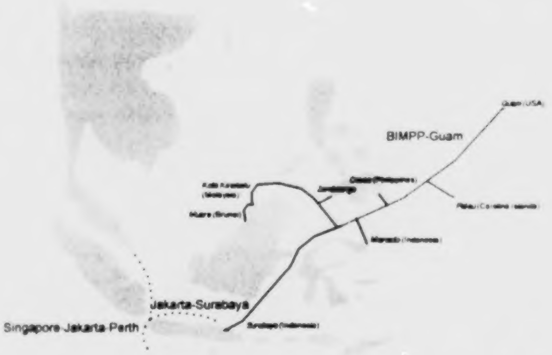
6.1 BIMPP - GUAM

This project intends to link together Brunei, Indonesia, Malaysia, the Philippines, the Palau Islands and Guam (USA). Several possible configurations are being studied. Figure 4 represents one of them. Three WDM Branching Units would be used in this configuration.

This project can serve as a regional network and can be used for restoration of adjacent networks like Malaysia Domestic or the future SEA ME WE 3 extension. It is a gateway towards the USA for the South-East Asia countries as well as for Australia with the connection of Perth-Jakarta-Singapore to SEA ME WE 3.

To allow for adjacent submarine network restoration, a certain number of wavelengths have to be reserved for this purpose. The other wavelengths directly connect the different countries depending on traffic requirements.

FIGURE 4. BIMPP-GUAM



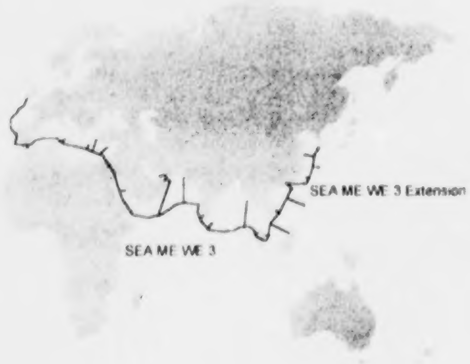
6.2 SEA ME WE 3 AND ITS EXTENSION

As shown in figure 5, the SEA ME WE 3 project will link Europe to South-East Asia via more than 20000km of submarine cable. More than ten branches and six terminating stations will allow the connection of more than twenty countries.

Up to eight wavelengths carrying 2.5 Gbit/s of traffic each will be multiplexed using two fibre pairs for network protection.

A few months after the SEA ME WE 3 project, an extension will be implemented in Asia connecting more than ten countries from Singapore to Korea and Japan with branches to Malaysia, Brunei, Vietnam, Hong Kong, Macao, Taiwan, China and the Philippines.

FIGURE 5. SEA ME WE 3 AND ITS EXTENSION

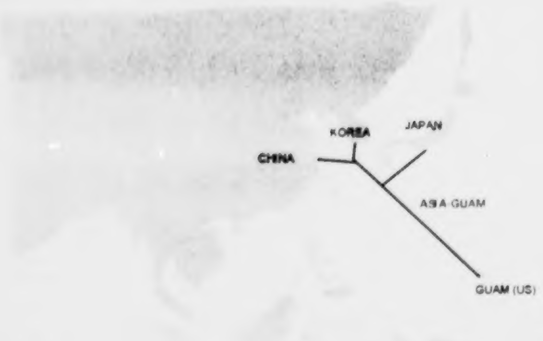


6.3 ASIA-GUAM

Figure 6 shows the Asia-Guam possible route. This project could link China, Korea and Japan to Guam (USA). Each country would have dedicated wavelengths each carrying 2.5 Gbit/s towards Guam ensuring independent access to North America.

Additional wavelengths could be used for the restoration of adjacent networks like the SEA ME WE 3 extension.

FIGURE 6. ASIA-GUAM

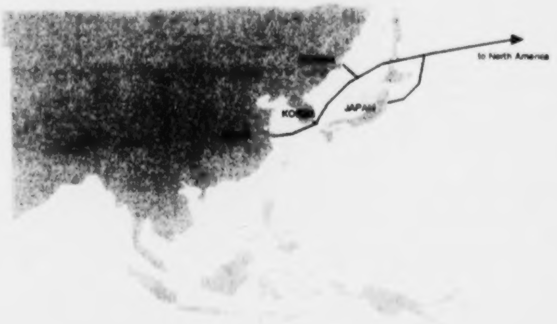


6.4 NORTH PACIFIC CABLE 2

Considering the important amount of current and future traffic towards the USA, it is necessary to consider new systems between Asia and North America. This need is recognized by all major carriers in the region with a delivery target as close as the year 2000.

Furthermore, direct connectivity between China, Korea and North America is an alternate to classical routes like TPC5. It can also act as network restoration of the latter by dedicating spare wavelengths for this purpose.
Figure 7 shows a possible implementation.

FIGURE 7. A POSSIBLE IMPLEMENTATION OF NPC2



7. THE LOOP CONCEPT

The above systems as well as other potential projects are real networks themselves carrying up to 20 Gbit/s of information on a single fibre. They will face acute restoration problem in the event of a cable cut if no alternate traffic routing is provided. The associated loss of revenue could be significant if these individual projects are not integrated together.

What WDM networking can offer is the ability to secure each individual network by reserving part of the capacity to a dedicated restoration route. A loop concept can be introduced where several projects are linked together, forming a loop along which traffic wavelengths can circulate whilst providing spare wavelengths for traffic protection and future upgradability.

FIGURE 8. EXAMPLE OF A REGIONAL LOOP (1)

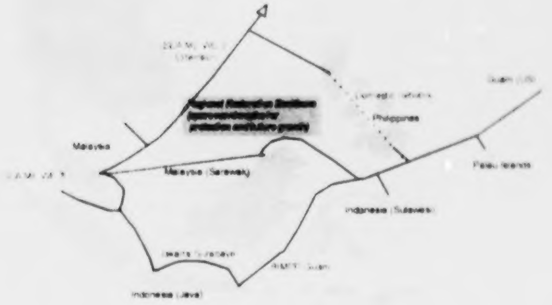
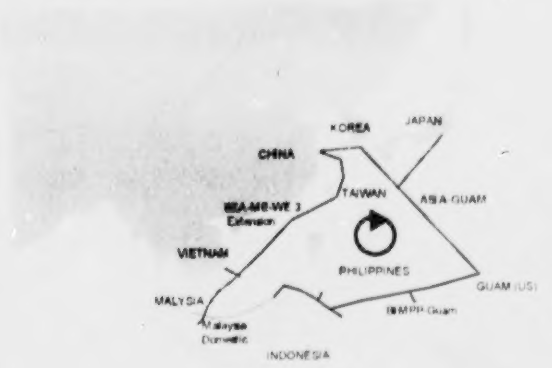

Guam (US)
Philippines
Malaysia
Malaysia (Sarawak)
Palau Islands
Indonesia (Sulawesi)
BIMPP Guam
Indonesia (Java)

Figure 8 illustrates this loop concept where a link between the continental part of Malaysia and the Malaysian Sarawak state can provide a number of solutions at the same time:
-domestic Malaysian traffic,
-protection of the BIMPP-Guam project, using the Surabaya-Jakarta system (currently being implemented) and the Jakarta-Singapore branch of the Perth-Jakarta-Singapore connection to SEA WE ME 3,
-protection of the SEA ME WE 3 extension.

This loop concept can also be extended to longer spans or systems. An alternative to the previous restoration scheme is shown in figure 9 below. In this approach, Malaysia Domestic (which is supposed in this example to be WDM upgraded), the SEA ME WE 3 extension, the Asia-Guam and the BIMPP-Guam projects secure each other.

FIGURE 9. EXAMPLE OF A REGIONAL LOOP (2)


KOREA
JAPAN
CHINA
TAIWAN
ASIA GUAM
SEA-ME-WE 3
Extension
VIETNAM
PHILIPPINES
GUAM (US)
MALYSIA
BIMPP Guam
Malaysia
Domestic
INDONESIA

To illustrate how this happens in terms of wavelength reallocation, figures 10 and 11 show a possible scheme. In figure 10 the dotted lines represent the spare wavelengths reserved for restoration. These wavelengths should be available in each system from SEA ME WE 3 to Malaysia Domestic. If a cable cut occurs in the BIMPP-Guam portion of the loop (for example between Indonesia and the Philippines), the traffic from Malaysia to Guam could be rerouted via the SEA ME WE 3 extension and the Asia-Guam system towards Guam, as shown in figure 11.

FIGURE 10. WAVELENGTH ALLOCATION (PRIOR TO CABLE CUT)

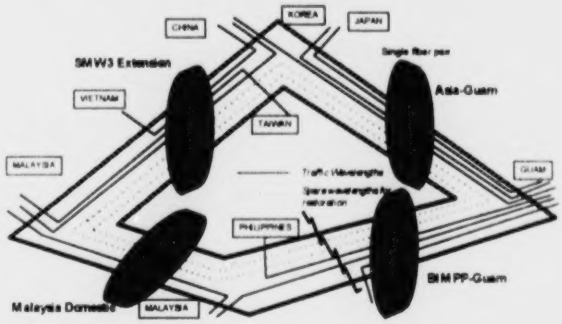
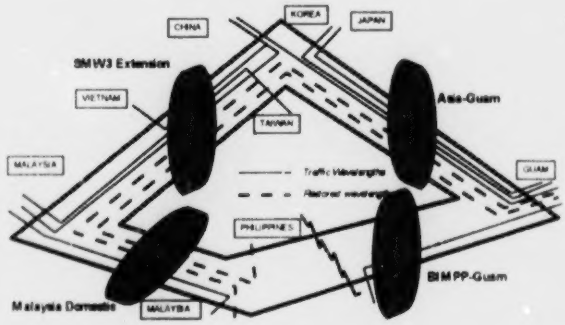

CHINA
KOREA
JAPAN
SMW3 Extension
Single fiber pair
Asia-Guam
VIETNAM
TAIWAN
MALAYSIA
GUAM
Traffic Wavelengths
Spare wavelengths for restoration
PHILIPPINES
BIMPP-Guam
Malaysia Domestic
MALAYSIA

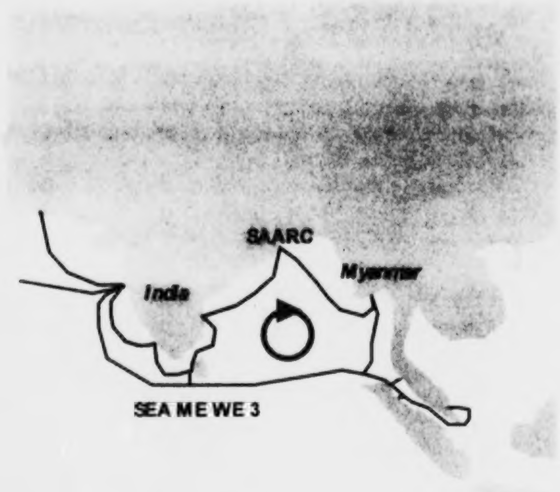
FIGURE 11. WAVELENGTH ALLOCATION (AFTER RESTORATION)


CHINA
KOREA
JAPAN
SMW3 Extension
Asia-Guam
VIETNAM
TAIWAN
MALAYSIA
GUAM
Traffic Wavelengths
Restored wavelengths
PHILIPPINES
BIMPP-Guam
Malaysia Domestic
MALAYSIA

Another example of loop restoration can be found in the Bay of Bengal where several projects are being investigated (see figure 12):
*the SAARC project linking Pakistan, India with several landings, Sri Lanka and Myanmar,
*the SEA ME WE 3 (segment 1) which could close the loop in this region with its branch to Myanmar.

All these projects are based on n * 2.5 Gbit/s links. Each of them can clearly secure and restore the traffic of the adjacent networks in the loop.

FIGURE 12. SEA ME WE 3 / SAARC



The Australasian loop offers another example. This region is currently linked to Guam via Pacrimwest which is a 2 * 560 Mbit/s system. This is a gateway towards Asia and the USA. Another 2 * 560 Mbit/s system, Pacrimeast, links it to the USA. In the near future Jasuraus will link Australasia to Indonesia using 5 Gbit/s technology.

The latter system is not secured and any cable damage will cut off the traffic towards Asia. Hence another route must be created to allow for restoration of this traffic.

On the other hand Pacrimwest is nearly full and Pacrimeast will be full by the end of the century. The Olympic games in the year 2000 and the continued tremendous growth in Internet traffic will both be major factors in an increasing demand for traffic bandwidth.

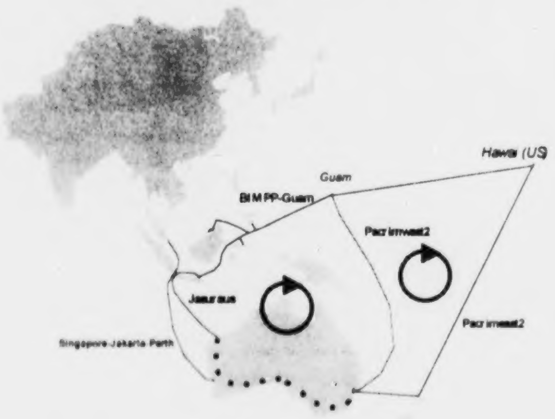
Answers to these challenges could be on one hand a second Pacrimwest and/or Pacrimeast. On the other hand a Singapore-Jakarta-Perth system linking Australia to SEA ME WE 3 would provide restoration capability to the Jasuraus system as well as giving more capacity towards Asia and Europe.

An adhoc wavelength allocation scheme would provide upgrade of the capacity by adding more wavelengths to the system. Extra wavelengths would allow restoration of Jasuraus traffic and, as a consequence, potential restoration of other systems like BIMPP-Guam via Pacrimwest2 and eventually the Australian terrestrial fiber network.

Furthermore, Pacrimwest2 and Pacrimeast2 will secure each other via systems like TPC-6.

Figure 13 shows a summary of these options.

FIGURE 13. AUSTRALASIAN LOOP

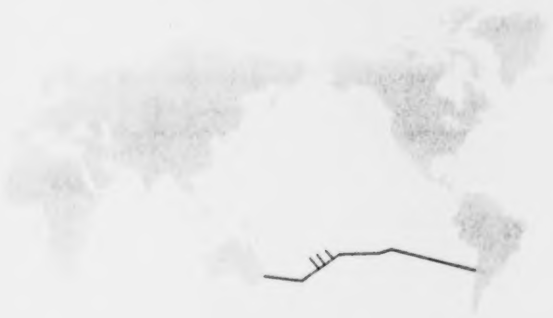


8. WDM COST SAVINGS

Taking advantage of the WDM loop concept gives significant cost benefits as listed below:

*Economies of scale: one (or two) fibre pair(s) can be shared by a large number of landing parties. More landing parties also mean easier finâncing. This is typically the case of the SEA ME WE 3 project and its extension. The same idea could also be applied to a potential Pacific Transit Cable as shown in figure 14. Furthermore, this cable in association with the Pan-America system could secure a Pacrimeast2 project hence lowering the cost of the project itself.

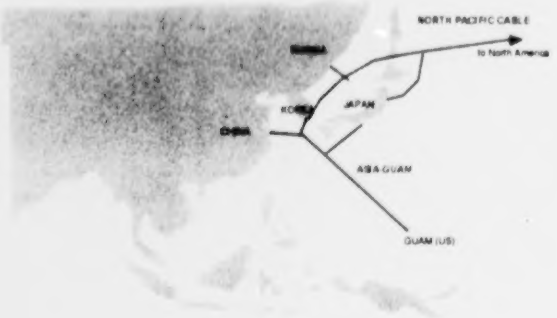
FIGURE 14. PACIFIC TRANSIT CABLE



*Each landing party can configure its station to its real needs (in terms of number of wavelengths). There is no need to access the entire trunk signal as in 5 Gbit/s systems. This is particularly useful when mixing domestic and international traffic on the same fibre or when a rather small domestic network is dimensioned to allow for adjacent international network restoration.

*It eliminates node bottleneck due to the route diversity that can be offered by the loop concept. Figure 15 illustrates it where Guam is no more the only gateway to North America when combining together the Asia-Guam and NPC2 projects with mutual network restoration via spare wavelengths.

FIGURE 15. NPC2 / ASIA-GUAM



*It gives ease of reconfiguration by simple wavelength reallocation (refer to figures10 and 11).

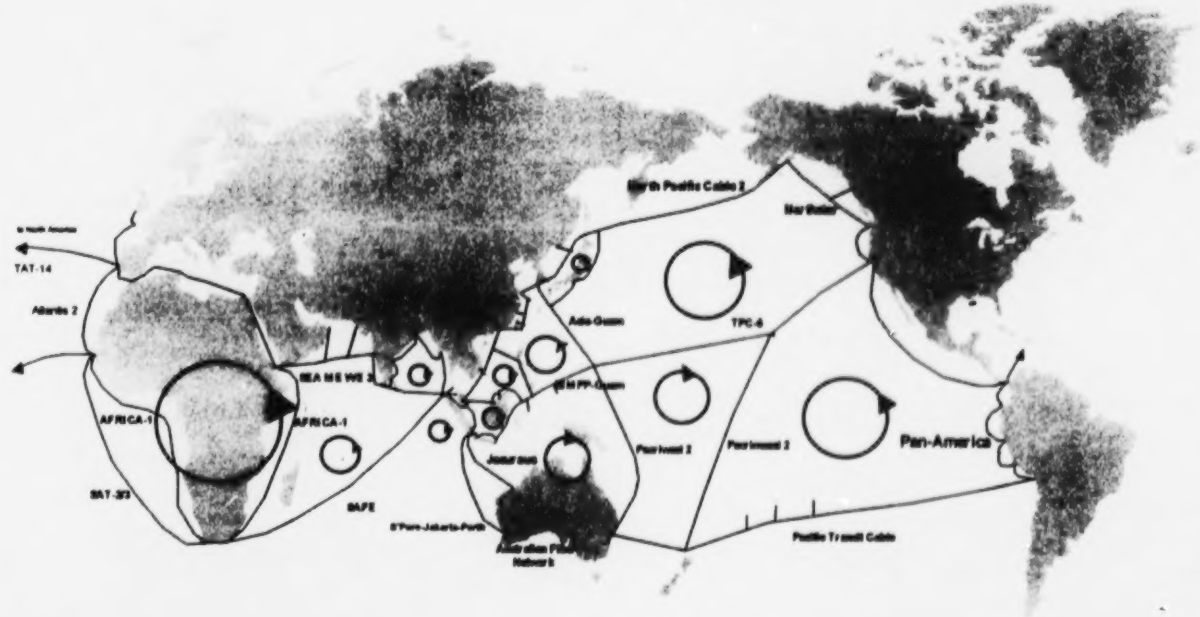
*Systems can grow progressively with traffic demand by equipping new landing stations during the lifetime of the system. Furthermore, additional wavelengths can be added to the initial setup. This minimizes the initial investment.

*Equipment protection is needed no more since network protection can achieve even better protection.

*In the case of a cable cut in branches, revenues can be partly preserved by wavelength and/or traffic rerouting since no transit traffic is needed in the branched nodes.

9. TOWARDS WORLDWIDE CONNECTIVITY

FIGURE 16. WORLWIDE CONNECTIVITY


to North America
TAT-14
Atlantis 2
AFRICA-1
SAT-2/3
SEA ME WE 3
AFRICA-1
SAFE
S'Pore-Jakarta-Perth
Australian Ring Network
Asia-Guam
North Pacific Cable 2
Northstar
TPC-6
Pacrimeast 2
Pacrimeast 2
Pan-America
Pacific Transit Cable

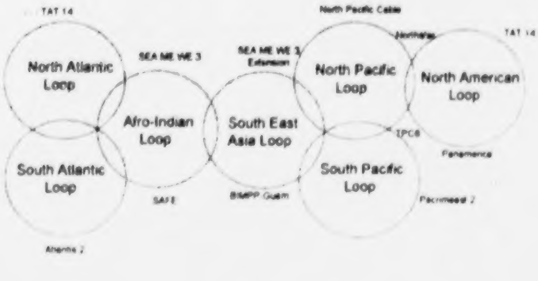
The loop concept can be extended from region to region, from region to continent and from continent to continent. Figure 16 shows a possible arrangement based on this approach.

When comparing Asia-Pacific to the networking in other regions and continents, one can identify several WDM loops linking together major WDM projects:

*the North Pacific loop involving NPC2, Northstar, TPC6 and Asia-Guam,
*the South Pacific loop involving Pacrimeast2, Pan-Americas and Pacific Transit Cable,
*the Afro-Indian loop involving SEA ME WE 3, SAFE and Africa-1.

These loops connected to the above inter-Asia loops can further be combined to the rest of the world. As indicated in figure 17, North and South Atlantic loops as well as a North America loop can be added to form a future fully secured worldwide submarine network.

FIGURE 17. MAIN WORLWIDE LOOPS


TAT 14
North Atlantic Loop
South Atlantic Loop
Atlantis 2
SEA ME WE 3
Afro-Indian Loop
SAFE
SEA ME WE 3 Extension
South East Asia Loop
BMPP Guam
North Pacific Cable
North Pacific Loop
Northstar
TPC6
South Pacific Loop
Pacrimeast 2
TAT 14
North American Loop
Panamerica

10. CONCLUSION

The advent of WDM technology introduces another important step change in submarine systems planning.

The combination of very high capacity, networking flexibility and upgrade capability will drastically influence the shape of all future systems. These new optical highways connecting an increasingly large number of countries create a restoration issue: the loop concept provides the answer to vulnerability by allowing one network to be restored by other adjacent networks.

Furthermore, economies of scale can be achieved by linking on the same fibre several countries and mixing domestic and international traffic. Nevertheless all these networks will take all the benefits of WDM both technically and financially if, and only if, they are not considered in isolation.

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*"8 * 2.5 Gbit/s WDM transmission over 6000 km with wavelength add-drop multiplexing" - *O.Gautheron, G.Bassier, V.Letellier, G.Grandpierre, P.Bollaert*
Electronics Letters, Vol.32, n.11, p.1019-1020

Biography

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*Master of Science from Imperial College (London, UK)

*Executive MBA (IFG-Paris, France)

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The Introduction of SIM Services into CDMA Cellular Networks

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ABSTRACT

While the GSM cellular network provides both terminal mobility and personal mobility using the *Subscriber Identification Module* (SIM), the CDMA cellular network, which has just begun to be recognized as a commercially viable cellular technology, has not yet provided SIM service. Accordingly, several convenient services are not available for CDMA subscribers: flexible telephone services, authentication, and other transport mechanisms for end-to-end wireless data services.

In this paper, we propose the implementation of SIM service in an IS-95 based CDMA network. We propose the configuration, file structure of the SIM card, and commands between Mobile Equipment (ME) and SIM. We present the implementation of the SIM-based reciprocal *plastic roaming* service between GSM and CDMA networks. The reciprocal authentication of a roamer in the GSM and CDMA networks is described as well.

1 Introduction

Because people all over the world are increasingly mobile, roaming with overseas and domestic cellular operators has great potential as a big business. The roaming service is not only potentially highly profitable but also a powerful competitive weapon in the wireless market. This point is well proven by the fact that a dramatic rise in the popularity and usage of GSM cellular technology across continental Europe has mainly been a result of its superior roaming capability. Another distinguishing feature of the GSM network is that the SIM card provides authentication service, a secure means of preventing fraudulent criminals from accessing the network illegally. Considering the prevalence of fraud and the resulting damage to the cellular operator's revenue, a powerful SIM-based authentication mechanism is regarded as a crucial element for the successful launch of a roaming service.

Even though the cellular network implements the authentication mechanism in order to protect the network against unauthorized access, there still remains a possibility that the fraudulent criminal can successfully alter or clone the subscriber identity stored in the handset, unless the subscriber identity is removed from the handset and saved in the SIM. The subscriber identity stored in the SIM card is protected by the *Card Operating System* (COS) of the SIM card. No successful attempt of cloning SIM has been reported yet.

For this reason, we propose the SIM-based authentication service in the CDMA network and the SIM-based reciprocal plastic roaming service between GSM and CDMA networks. In addition to these services, the proposed SIM card enables the cellular operator to offer many other SIM services such as prepaid services and electronic wallet services.

This paper is organized as follows. We first review the SIM services currently available in the GSM network and explain how SIM prevents the fraudulent criminal from illegal access to the GSM network. We then describe configurations of the proposed CDMA SIM card. The SIM card file structure and the control commands between the SIM card and ME are also explained. The newly defined commands, *Run CDMA Authentication* and *Update SSD*, will be used to authenticate CDMA subscribers. The proposed SIM card complies with the specifications of the GSM 11.11 standard and thus operates exactly in the same way as a conventional GSM SIM card. Consequently, the SIM-based plastic roaming of a CDMA subscriber into the GSM network is easily implemented by introducing interworking nodes and with CDMA SIM inserted into a regular GSM handset. The GSM subscriber's plastic roaming into the CDMA network is also possible simply by inserting the roamer's own GSM SIM card into the CDMA handset and turning the handset power on. We illustrate roaming between GSM and CDMA networks and describe in detail the operation of three basic elements required for a roaming service: registration, authentication, and call delivery .

2 Fraud Prevention and the SIM card in GSM Networks

The GSM is the first international cellular system that implements the authentication of the subscription and subscriber by making use of a *removable* SIM card. The GSM handset physically consists of two separate parts: the Mobile Equipment (ME) and the SIM card. All information pertaining to a subscriber's identity, for example the cellular phone number, and all information related to authentication, such as the authentication algorithm, are stored in the SIM card. The information and algorithm saved in the SIM are protected against illegal access by the COS. ME is the remaining collection of hardware and software components of the handset required for regular operation of the cellular handset. This concept of a removable SIM card provides cellular operators with a secure means to completely control subscription and authentication related information and algorithm.

The authentication of a cellular subscriber is performed in two steps. First, both the SIM card and home *Authentication Center* (AC) execute an "identical" authentication algorithm, denoted by A_3, using "identical" input parameters: (1) the secret authentication key, K_i, which is unique to each subscriber and (2) the non-predictable random number, *RAND*, which is transmitted from AC to the SIM card. Second, the serving Visitor Location Register (VLR) compares the result received from the home AC with the result calculated and sent by the SIM card. No one but the cellular operator has the information regarding the authentication algorithm and K_i. Therefore, only the legally valid SIM card can submit a result that is equal to the value computed by the home AC. In this way, illegal access to the GSM network is completely prohibited. The cellular operator can choose any authentication algorithm. The only requirement is that authentication algorithm resident in the AC and SIM card should be identical. The authentication algorithm, thus, is usually different from one cellular operator to another.

The authentication procedure referred to as the *Challenge-Response* mechanism is illustrated in Figure 1 and can be summarized as follows:

1) Once the GSM network receives an authentication request from the GSM handset, the serving network transmits a random number, RAND, to the ME in order to *challenge* the corresponding handset. The ME forwards the received RAND to the SIM card.

2) The SIM card executes the authentication algorithm, A_3 and generates the signed result (SRES) as shown in Figure 1. RAND and the secret key, K_i stored in the SIM are used in calculating the SRES. K_i is uniquely assigned to each SIM card when the card is issued by cellular operators and is not exchanged between the AC and SIM card. Therefore, no one but the cellular operator can obtain the value of K_i.

3) The response to challenge is accomplished by transmitting the SRES from the SIM card to the serving network via the ME. The SRES sent from the SIM card is then compared with a value computed independently by the home AC. Since both the SIM card and the AC execute identical authentication algorithms using the identical RAND and K_i, the results computed by the SIM card and the home AC should be identical for a legal subscriber.

4) If the SRES received from the handset is equal to the value computed by the home AC, the handset is regarded as a legal one and thus granted access to the network. If the handset turns out to be an illegal one, the handset is prohibited from accessing the GSM network.

In addition to the authentication services mentioned above, the SIM card allows many other convenient cellular services such as prepaid services, abbreviated dialing services, and short message services. The specifications regarding the functionality of the GSM SIM card and the interface between the SIM and ME are defined in GSM 02.17 [1] and GSM 11.11[2], respectively.

3 CDMA Smart Card Configurations

In this section, we propose the configuration of the CDMA SIM card and the interface between the CDMA SIM card and CDMA ME. The SIM card configuration specifies what kind of information is stored in what structure in the SIM card. The interface specification defines the communication protocol between the ME and SIM card, and thus specifies how the ME retrieves or updates information saved in the SIM card and how the ME requests the SIM to return the computation result after executing a specified algorithm. The proposed SIM card does not require any modification of the CDMA specification defined in the IS-95 standard [3] and thus can be easily implemented for a commercial service.

3.1 SIM Configurations and Interface Specification between ME and SIM

One of the main functions of the SIM card is to execute an authentication algorithm upon request from the ME and to save the associated keys and other information related to the subscriber. As shown in Figure 2, the SIM card consists of *dedicated files* (DF) which in turn consists of a set of *elementary files* (EF). Each EF contains specific subscriber relevant information or authentication related data. The proposed CDMA SIM card also includes dedicated files and elementary files defined in GSM standards. These file structures completely comply with the GSM standard so that we can provide a plastic roaming between the GSM network and the CDMA network. Section 4 will describe plastic roaming in detail.

The interface between the proposed SIM card and the ME is basically the same as the interface defined in the GSM 11.11 standard. However, since we present a CDMA authentication procedure which is different from the authentication procedure defined in the GSM standard, we need to define two additional commands between the ME and SIM card as follows:

1) *RUN CDMA Authentication*

This command requests the SIM card to calculate and return an authentication response, AUTHR. The cellular operator has freedom to choose its own authentication algorithm.

2) *Update SSD*

This command requests the SIM card to update shared secret data, SSD which is partitioned into SSD-A and SSD-B. This request may be the result of administrative procedures at the AC, expiration of an authentication time interval at the AC, or the report of a security violation from a visited system.

Section 3.2 will describe in detail the proposed SIM-based authentication procedure.

3.2 SIM-based Authentication in CDMA Network

The authentication procedure proposed in this paper is basically the same as the procedure defined in the IS-95 standard and IS-41 MAP network protocol [4]. The main difference is that the SIM card serial number, *SCid*, is used as an input parameter to authentication algorithm instead of the Electronic Serial Number (ESN). This is because the ME's serial number, ESN, is not unique for each subscriber anymore due to the removable nature of the SIM card, but *SCid*, a number uniquely assigned to each SIM card by a service provider, can uniquely identify each subscriber. The authentication procedure is illustrated in Figure 3 and can be summarized as follows:

1) The base station (BS) periodically updates and broadcasts a random number, RAND.

2) Whenever the handset performs registration, places an outgoing call, or responds to a paging message from the base station, the ME requests the execution of the authentication algorithm to the SIM using the *RUN CDMA Authentication* command.

3) The SIM calculates the authentication result, AUTHR, using RAND, the shared secret data, SSD-A, the mobile identity number (MIN), and the SIM card serial number, *SCid* as input data. The computation result, AUTHR, is then transmitted to the AC along with RAND and the call history count, *COUNT*.

4) Upon receiving AUTHR from the SIM card, the AC compares AUTHR with the value computed by the AC itself. If the two values are the same, access to the CDMA network is granted for the corresponding handset. If the authentication fails, the network usually initiate *Unique Challenge* procedure [5].

4 SIM-based Reciprocal Plastic Roaming

The SIM card is an efficient means to implement reciprocal roaming between cellular networks employing non-compatible air interfaces. In this section, we present the implementation of SIM-based plastic roaming between GSM and CDMA networks. The proposed implementation generally can be applied to roaming between other cellular networks, for example roaming between GSM, CDMA, TDMA, and PHS networks.

The reciprocal roaming can be implemented in various ways. The first solution is to carry a dual mode handset. Based on the received air signals transmitted from a base station, the handset decides its operation mode: GSM mode when a roamer is located in the GSM network and CDMA mode in the CDMA network. This solution quite simply allows the subscriber to freely roam between cellular networks with different cellular standards. However, this approach has drawbacks in that a dual-mode handset is usually heavier to carry and costs more than a single-mode handset.

The second solution is to use a dual-mode or a multiple-mode SIM card with an "*appropriate*" handset. In order to access the cellular network the roamer is currently visiting, it is enough to insert the roamer's own multiple-mode SIM card into a suitable handset: a GSM handset for the GSM network, and a CDMA handset for the CDMA network. The only requirement is to design a multiple-mode SIM card so that each mode complies completely with the associated cellular standard. The second approach has a few advantages. First, the development of a multiple-mode SIM card is much simpler and costs less than the development of a multiple-mode handset. Second, the subscriber can access various cellular networks by simply carrying a multiple-mode SIM card and a suitable ME.

4.1 Network Configuration

In this section, we explain the network configuration and operation for SIM-based reciprocal roaming between GSM and CDMA networks. The *Interworking Node*, shown in Figure 4, is introduced to perform (1) the protocol conversion between the GSM MAP [6] and IS-41 MAP, (2) authentication, and (3) other interworking functions such as routing number translation.

4.2 Roaming from GSM to CDMA

The GSM subscriber visiting the CDMA network can initiate and receive calls simply by inserting a personal GSM SIM card into the CDMA handset. The detailed network protocol and operation are illustrated in Figure 5, Figure 6, and Figure 7.

A. Location Registration

Location registration enables the Home Location Register (HLR) to keep track of the subscriber's mobility. Figure 5 illustrates the location registration of a GSM roamer to a serving CDMA network, which is different from "conventional" location registration in that we have to introduce an *Interworking Node* in order to perform the protocol conversion between the IS-41 MAP and GSM MAP.

B. Authentication

Once the GSM subscriber accesses the CDMA networks, the CDMA network requests the authentication result through the *Interworking Node* by using the IS-41 MAP procedure. The *Interworking Node* converts the authentication request to a GSM MAP procedure, then sends it to the home GSM network. The GSM network sends back the security triplets to the *Interworking Node*. Then, the *Interworking Node* orders a Unique Challenge authentication to the CDMA network using the received security triplets. Figure 6 shows this authentication procedure.

C. Call Delivery

An incoming call to a GSM user is first routed to the user's home GSM network. The home GSM network knows the CDMA network to which the user has roamed. Then, the home GSM network requests the roaming number through the *Interworking Node*. Using the roaming number, the call is routed to the CDMA network through PSTN. Figure 7 shows this procedure.

4.3 Roaming from CDMA to GSM

The CDMA subscriber visiting the GSM network can initiate and receive calls simply by inserting a personal CDMA SIM card into the GSM handset. The detailed network protocol and operation are illustrated in Figure 8, Figure 9, and Figure 10.

A. Location Registration

A CDMA user roaming to the GSM network has to make a location registration in order to be served by the GSM network. As described in section 4.2, the CDMA subscriber is registered by using the MAP procedure shown in Figure 8.

B. Authentication

Once the CDMA subscriber accesses the GSM networks, the GSM network requests authentication information to the home CDMA network. The *Interworking Node* converts the authentication information request to a CDMA MAP message, then sends it to the home CDMA network. The current CDMA system can not generate the security triplets because the authentication result is compared in the home authentication center, and therefore, there is no need to generate and send security information to the other network entities. For authenticating a CDMA subscriber roaming into the GSM network, we define a new MAP operation, *Authentication Information Request*. Using this new operation, the GSM network gets the security triplets as shown in Figure 9.

C. Call Delivery

An incoming call to a CDMA subscriber is first routed to the subscriber's home CDMA network. The home CDMA network knows the GSM network to which the user has roamed. Then, the home CDMA network requests the routing number through the *Interworking Node*. Using the routing number, the call is routed to the GSM network through PSTN. Figure 10 shows this procedure.

5 Conclusion

SIM services offer many benefits to cellular subscribers as well proven in the GSM network. In this paper, we addressed the implementation issues related to the introduction of SIM service into IS-95 based CDMA networks. We first reviewed SIM services currently available in the GSM network and described in detail how handset cloning and other fraud are prevented by the SIM-based authentication. We then proposed a SIM card configuration and the file structures required for authentication and plastic roaming services for CDMA subscribers. Additional interface specifications between ME and SIM were defined and proposed as well. After describing the authentication service in both GSM and CDMA networks, we presented the network configuration and operation for a reciprocal SIM-based plastic roaming between GSM and CDMA networks.

References

[1] GSM 02.17 : "*European digital cellular telecommunication system (Phase 2); Subscriber Identity modules Functional characteristics*".
[2] GSM 11.11 : "*European digital cellular telecommunication system (Phase 2); Specification of the Subscriber Identity Module - Mobile Equipment (SIM-ME) Interface*".
[3] IS-95, "*Mobile Station - Base Station Compatibility Standard for Dual-Mode Wideband Spread Spectrum Cellular System*".
[4] TIA/EIA/IS-41 Revision C, " *Cellular Radio Telecommunications Intersystem Operations: Signaling Protocols*", Feb. '96.
[5] V. J. Garg, "*Interworking and Interoperability Issues for North American PCS*", IEEE Comm. Magazine, Mar. '96.
[6] GSM 09.02 : "*European digital cellular telecommunication system (Phase 2); Mobile Application Part (MAP) specification*".

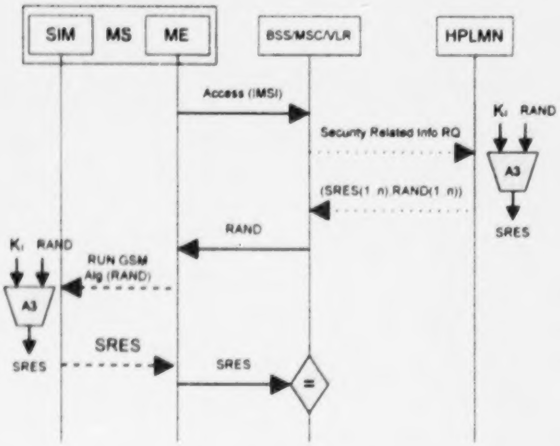
SIM
MS
ME
BSS/MSC/VLR
HPLMN
Access (IMSI)
Kᵢ RAND
Security Related Info RQ
A3
(SRES(1..n),RAND(1..n))
SRES
RAND
Kᵢ RAND
RUN GSM Alg (RAND)
A3
SRES
SRES
SRES
=

Figure 1 GSM Authentication

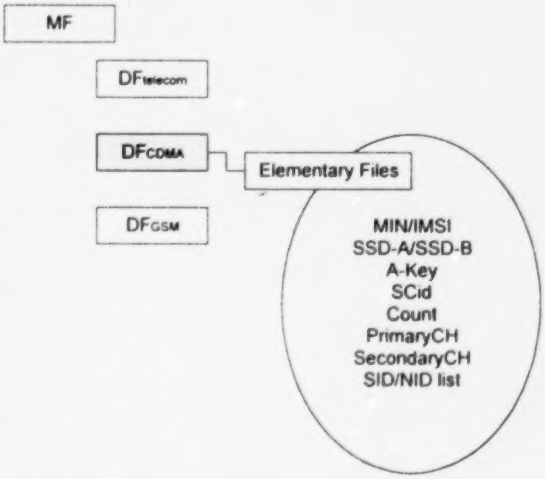
MF
DFtelecom
DFCDMA
Elementary Files
DFGSM
MIN/IMSI
SSD-A/SSD-B
A-Key
SCid
Count
PrimaryCH
SecondaryCH
SID/NID list

Figure 2 CDMA SIM Directory

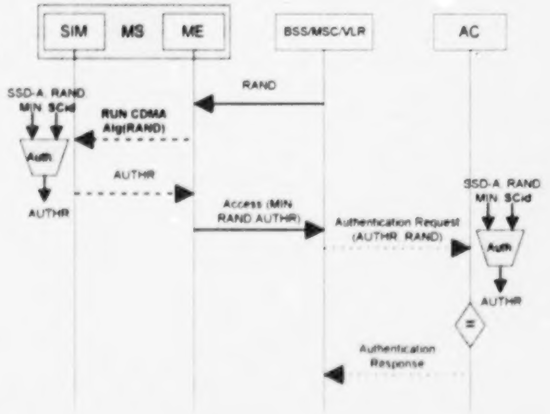
SIM
MS
ME
BSS/MSC/VLR
AC
RAND
SSD-A RAND
MIN SCid
RUN CDMA Alg(RAND)
Auth
AUTHR
AUTHR
Access (MIN RAND AUTHR)
Authentication Request (AUTHR RAND)
SSD-A RAND
MIN SCid
Auth
AUTHR
=
Authentication Response

Figure 3 CDMA Authentication with SIM

604

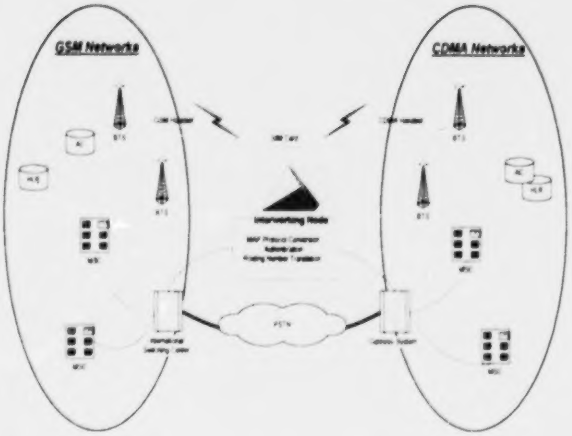
GSM Networks
CDMA Networks
BTS
BTS
AC
HLR
MSC
MSC
PSTN
Interworking Node
BTS
BTS
AC
HLR
MSC
MSC
PSTN

Figure 4 Network Architecture for Plastic Roaming

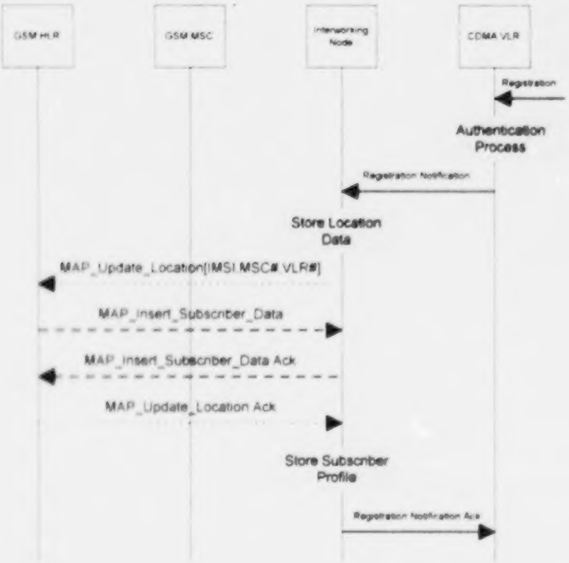
GSM HLR
GSM MSC
Interworking Node
CDMA VLR
Registration
Authentication Process
Registration Notification
Store Location Data
MAP_Update_Location[IMSI,MSC#,VLR#]
MAP_Insert_Subscriber_Data
MAP_Insert_Subscriber_Data Ack
MAP_Update_Location Ack
Store Subscriber Profile
Registration Notification Ack

Figure 5 Location Registration for roaming GSM to CDMA

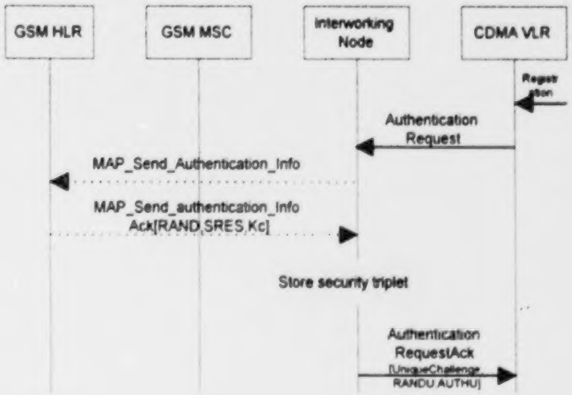
GSM HLR
GSM MSC
Interworking Node
CDMA VLR
Registration
Authentication Request
MAP_Send_Authentication_Info
MAP_Send_authentication_Info Ack[RAND,SRES,Kc]
Store security triplet
Authentication RequestAck
[UniqueChallenge, RANDU,AUTHU]

Figure 6 Authentication for roaming GSM to CDMA

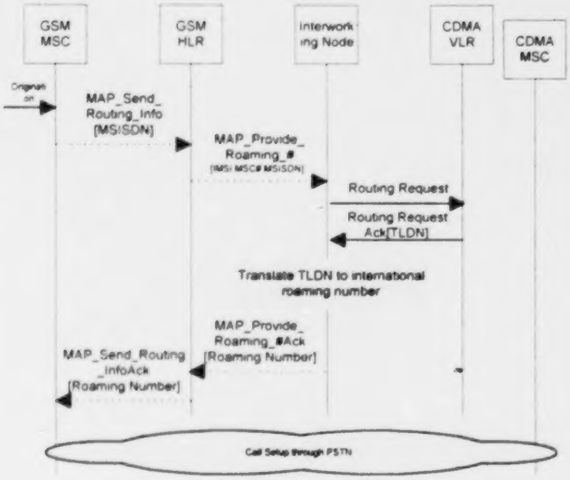
GSM MSC
GSM HLR
Interworking Node
CDMA VLR
CDMA MSC
Origination
MAP_Send_Routing_Info [MSISDN]
MAP_Provide_Roaming_#
[IMSI,MSC#,MSISDN]
Routing Request
Routing Request Ack[TLDN]
Translate TLDN to international roaming number
MAP_Provide_Roaming_#Ack [Roaming Number]
MAP_Send_Routing_InfoAck [Roaming Number]
Call Setup through PSTN

Figure 7 Call Setup for roaming GSM to CDMA

605

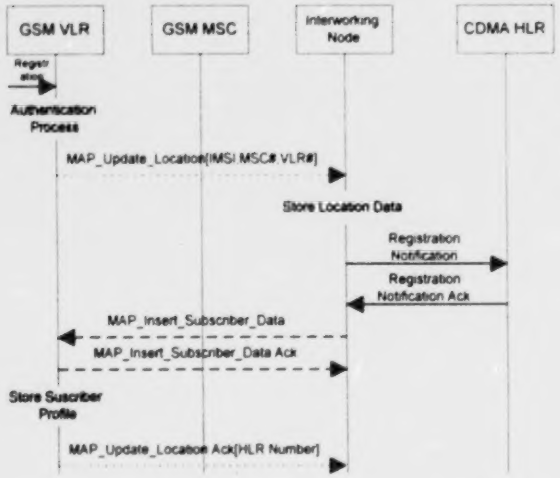
GSM VLR
GSM MSC
Interworking Node
CDMA HLR
Registration
Authentication Process
MAP_Update_Location[IMSI,MSC#,VLR#]
Store Location Data
Registration Notification
Registration Notification Ack
MAP_Insert_Subscriber_Data
MAP_Insert_Subscriber_Data Ack
Store Suscriber Profile
MAP_Update_Location Ack[HLR Number]

Figure 8 Location Registration for roaming CDMA to GSM

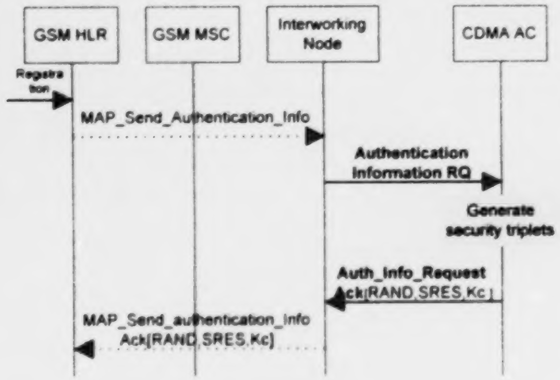
GSM HLR
GSM MSC
Interworking Node
CDMA AC
Registration
MAP_Send_Authentication_Info
Authentication Information RQ
Generate security triplets
Auth_Info_Request Ack[RAND,SRES,Kc]
MAP_Send_authentication_Info Ack[RAND,SRES,Kc]

Figure 9 Authentication for roaming CDMA to GSM

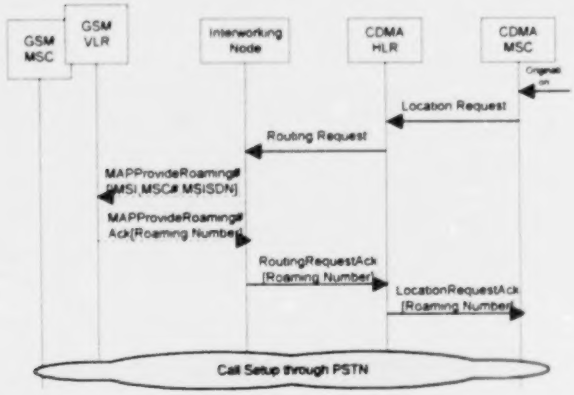
GSM MSC
GSM VLR
Interworking Node
CDMA HLR
CDMA MSC
Origination
Location Request
Routing Request
MAPProvideRoaming# [IMSI,MSC#,MSISDN]
MAPProvideRoaming# Ack[Roaming Number]
RoutingRequestAck [Roaming Number]
LocationRequestAck [Roaming Number]
Call Setup through PSTN

Figure 10 Call Setup for roaming CDMA to GSM

Communications Outlook - 1996-2006
Competition, Growth, Consolidation

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Jagdish N. Sheth
Massoud Saghafi

Summary

This paper summarizes two recently published research studies on the future of the information industry. Today's industry is based on information form. These forms (photography, printing, broadcast, analog electronics, data communications) have traditional vertical industries built around specific technologies. The impact of digital technology drives industry convergence into three major segments: content, transport, and appliances. Further, successful corporations must — through alliances, mergers, and acquisitions — become sufficiently strong to defend their markets. The overall marketplace is summarized together with competitive forecasts. Societal, economic, and trade impacts of the U.S. telecommunications infrastructure is presented together with forecasts of the state, ten years from now, of telephone, cable, cellular, and personal communications services companies. Overall, this paper provides an insightful look at the rapidly changing information industry.

Introduction

Over the next one to two decades, the worldwide telecommunications industry and its broadly based parent, the information industry, will undergo massive change.

Privatization of PTTs, regulations encouraging competition, and the issuance of wireless spectrum licenses are driving industry infrastructure and restructuring.

What will be the dimensions of the new information industry? Which drivers will be most significant in industry convergence? What will be the societal, economic, and trade impacts? How can traditional telephone, cellular, personal communications services, and cable companies thrive in the new information age?

These compelling questions are the basis of research studies at the International Engineering Consortium, University of Southern California's Center for Telecommunications Research, and the Institute for Communication Research and Education. These studies have included fundamental research coupled with thousands of executive and other expert interviews.

This paper summarizes two recently completed research studies which look at changes over the next decade and beyond.[1,2]

Today's Information Industry

Figure 1 presents a broad view of the information industry. As depicted in the columns, information exists in five basic forms: voice, text, image, data, and audio/video. Historically, each form of information has been dominated at the "retail" level by one or two industries. For example, imaging consists of cameras, films, industrial imaging, xerography and so on. Video information has primarily been the domain of entertainment-related industries such as consumer electronics, broadcast and cable television networks and Hollywood studios.

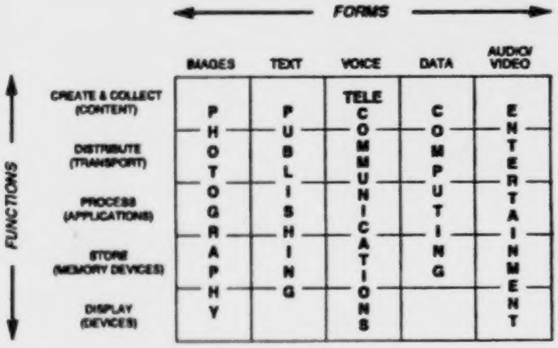

Figure 1. THE INFORMATION INDUSTRY OF TODAY

The horizontal dimension of the matrix captures what we do with information in each one of those industries: we create, display, store, process, or distribute information. We first examine the vertical columns: the forms of information.

Information industries have traditionally been defined in terms of the "form" of information, the underlying technologies for handling each type of information have been vastly different in the past, and each technology uniquely handled the form of information used by the industry.

Images: The imaging industry is large and diverse; it includes camera manufacturers, copier makers, film makers, and industrial and medical filming. The primary industry for images has been photography. Related industries include xerography and mimeography. The functions most emphasized in this industry have been information creation (via capture), storage, and display. The underlying technologies have historically been chemical.

Text. The principal technologies at the heart of the industry were the mechanical and electromechanical ones of printing and publishing. Supporting the publishing industry have been several supplier industries, such as the printing press industry, type foundries, the offset printing industry, the printing paper industry, and so on. With the advent of word processing and desktop publishing in the last two decades, the industry has started moving into digital technology.

Voice: The industry includes phone companies and other service providers at the "retail" level, and equipment manufacturers, copper wire producers, and numerous others at the supplier level. The primary functional emphasis of the telephone industry has been voice distribution, though recent growth has come through image (fax) and data transport. The principal technological underpinnings of the industry have been in the transmission and switching of electronic signals. For nearly a hundred years, these signals were analog; switches were first mechanical (human operators), then electromechanical (crossbars) and are now electronic. The technology is moving rapidly towards 100% software-controlled digital switching.

Data: Here, the major industry has been computing, which has its origins in the "tabulating" and "calculating" businesses. From mainframe computers, the industry moved to add minicomputers, and more recently personal computers, workstations, and supercomputers. For computing, the main emphasis has been on information storage and processing.

Audio/Video: This category includes audio information (such as music) as well as video information. The entertainment industry has "owned" these forms of information from the outset. Hollywood, music studios, and television networks have predominantly concentrated on content creation, though there are clearly storage, distribution (done by movie theaters, video, CATV or broadcast) and processing aspects to their business. The consumer electronics industry has been based largely on information display. Video-based businesses have thus been the most pervasive across the functions; they have excelled in content, display, and distribution (broadcast and cable networks).

Each Information Industry Form must perform a series of functions to ultimately serve its markets. This is depicted as five major functions in *Figure 1*.
Creation: The first function is the creation and collection of information content. The greatest opportunities lie in the collection, packaging, and channeling of content that is already being generated, while the development of new types of content represents a potentially large business in the future.

Distribute: Industries based on different forms of information have developed elaborate and largely separate infrastructures for distribution. The telecommunications industry has developed a vast, near-ubiquitous network of cooper wires. In the past decade, a wireless infrastructure based on cellular technology has also been created for voice communication. Text information has historically been distributed in a manner very similar to manufactured goods — from "factory" to intermediaries to end-users. Image information has largely ridden on the same infrastructure, which also includes the postal system and various express delivery companies.

Process: This function is the processing of information or the applications business: creating information out of data through intelligent manipulation. For voice information in the telecommunications industry, companies have used voice processing technologies. For text information, publishers have used word processors and desktop publishing software. In the imaging business, companies have primarily used chemical processes to improve images. For audio/video information, companies have relied heavily on editing and mixing technologies. Finally, processing has been (almost by definition) the most intensive for data applications.

Storage: Since the creation and consumption of information are typically separated, and since information tends to have lasting value, storing information is a very valuable function. Information can be stored through a variety of means: books, various magnetic media, WORM (write once, read may times) disks, CD-ROMs, microfiche, answering machines, film, videotape, audiotape, and game cartridges.

Display: This function is information display through terminals and devices. Display can be on papers, telephone sets, photographs, radios, PC screens, and televisions.
The traditional information industry depicted in *Figure 1* is undergoing a major transformation to a new convergence model which will result in substantial risks and opportunities for corporate players.

Corporations who recognize this major structural change and concentrate on being prominent within the new infrastructure will be well positioned for the future.

Digital Technology - The Primary Driver of Convergence

The primary driver of convergence of different forms of information is clearly technological change. The key technological change has been the rapid diffusion of digital technology into an ever-wider array of information businesses. Beyond digitization, dramatic changes in the computing and telecommunications industries are also driving convergence.

Figure 2 shows the economics of the digital age. Compared with former forms of applications, there is a large fixed cost in digital technology. The development of a chip and investment in plant costs billions of dollars. Software developments may cost hundreds of millions. The marginal cost of chips and software is very small. The impact of these economics is low selling price potential to mass markets.

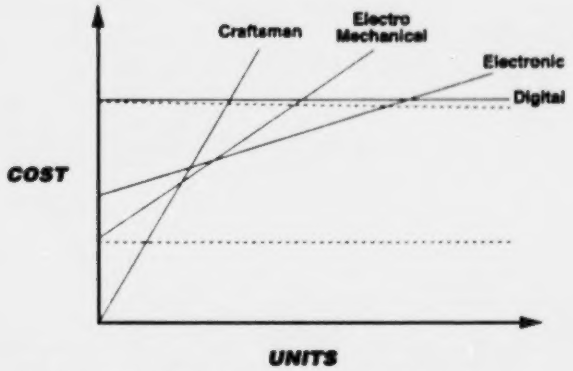

Figure 2. ECONOMICS OF THE DIGITAL AGE

Computer Hardware

The costs of computer hardware, relative to capabilities, declined dramatically during the 1980s and early 1990s, reflecting experience-based cost reductions and aggressive pricing strategies adopted by producers in order to expand their markets.

Already , the next generation of $300 video-game machines will put in childrens' hands the graphics power of a 1980s vintage Cray supercomputer. By 2010, the same device may fit in the palm of your hand and deliver photo-perfect images on a razor-thin display.

At the end of 1995, over 60 million PCs were shipped worldwide and approximately 39% of U.S. households now own a least one PC. There are approximately 12 million multimedia PCs in use, and the multimedia market is growing at more than 50% per year, with an estimated market size in 1995 of $10 billion.

Software

Software is becoming easier to use and more versatile. The widespread popularization of "graphical user interface" (GUI) systems (such as Macintosh's operating system and Microsoft's Windows 95) has made computers much more accessible to inexperienced users. The number and variety of application programs continues to grow rapidly.

Telecommunications

Advances in digital technology driven through fiber optics telecommunications promises even greater change of a discontinuous nature — we are likely to see an explosion of bandwidth in coming years that will dwarf anything seen in the past. The new explosions of bandwidth will enable interactive multimedia and video information to come into every household in various ways — through the air from satellites and terrestrial wireless systems, through fiber-optic cables and cable TV, and even phone-company coaxial cables.

As the information technology properties of convergence, versatility, and affordability illustrate, the new technological realities are far different. All information companies now harness essentially the same technologies. These technologies are all rapidly becoming multimedia by design. Prevailing industry configurations are thus being rendered obsolete, some at faster rates than others. Successful companies will have to be able to define the logic of their businesses along some other essential dimension or else risk irrelevance in the near future.

The Convergence of the Information Industry

There will be a structural impact on the migration of the entire information industry towards digital electronics:

- The industry will reorient itself along the horizontal axis depicted in *Figure 3* (i.e., based on functions).
- There will be a series of within-industry and cross-industry consolidations as major industry players position themselves for the future based on a cho-

sen functional specialization.

- The transformation will result in only three major industries (not five), which suggests that it is going to become more efficient in the process. The three industries will be providers of digitized content, multimedia devices, and convergent networks.

Companies that thrive in the future will therefore have:

- a bias toward personal rather than institutional markets
- greater expertise and experience with digital electronics
- a functional edge, i.e. outstanding expertise in performing one or more information functions
- more experience with video-based information (since, technologically, other forms of information are a subset of video)

In addition to the functional basis, three key factors will characterize the evolution of the information industry in coming years:

- Each new industry will be multimedia in nature, given the convergent nature of digital electronics.
- Each of the sectors will be global.
- The industry will become increasingly driven by a model in which personal markets rather than institutional markets will become the lead markets for technology deployment.

Content

Of the three primary sectors of the new information industry, the content area is farthest along in moving to the new model. First, a great deal of content is already digitized and ready to be used in multiple ways. Second, the rationalization of content businesses has been underway for some time, so that we already have large content entities such as Time Warner (which may soon add TBS) and the Viacom-Paramount-Blockbuster combination.

Highways - Distribution

Public telephone networks, cable television, broadcast media and private networks will be consolidated into the information transport business. These players will provide broadly based communications and content obtained from content providers in a variety of forms that meet the specific needs of the markets they serve.

The nerve system of the future information industry, indeed of the future global economy, will be a communication network of enormous capacity and sophistication. By the year 2010, a global network of virtually infinite capacity will be in place. It will be "network of networks," consisting of multiple, overlapping, and interconnected webs that collectively will realize the promise of huge two-way bandwidth to virtually every mode. During the next ten to fifteen years, convergent technologies will lead to worldwide end-to-end voice, data, fax, video, and image services. These services will begin between hub cities and work their way outward toward suburban and rural areas, much the way telephone service did in the 1920 and 1930s as well as the railroad and highway systems. The global network of networks will be both a transparent communications service and a platform for content-filled or content-enhanced services.

Appliances

Consumer electronics companies and personal computer manufacturers will converge into the multimedia devices (or as we prefer to call it, "information appliances") industry. As the PC gets more passive (receiving video streams like today's televisions), the TV will get more interactive; hence the convergence. The convergence of the telephone, television, and computer will lead to hybrid devices that combine the strongest features of each: like the television, the new devices will display video, sound, text, and be familiar and easy to use; like the telephone, they will allow people to communicate anywhere; and like the computer, they will be intelligent, powerful machines that take raw data and turn it into useful information.

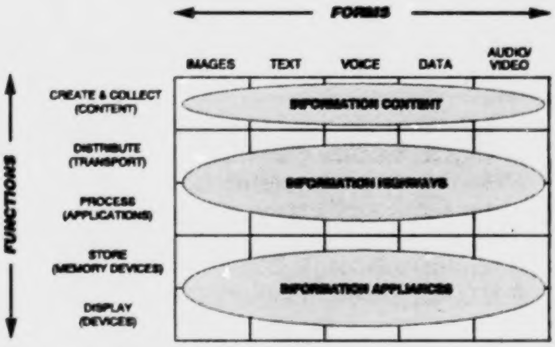

Figure 3. CONVERGENCE OF THE INFORMATION INDUSTRY

As the convergence of the information industry proceeds, there are many dimensions that will drive change. Research by the University of Southern California's Center for Telecommunications Research and the International Engineering Consortium's Committee on the Future has provided considerable insights into competition, customers, and markets. Also the economic, trade, and societal impacts have been forecast by panels of 300 experts for the 1997-2007 time frame.[2]

Competition, Customers, and Markets

Telco Market

The long distance telephone revenues in the United States is expected to grow to $100 billion in ten years. Local exchange revenues, including access charges, will reach $120 billion by 2007.

The average monthly bill of a typical American household is expected to rise very slowly over time to just under $21/month by 1997 from its current $20 level, and to only $25 by 2007. Over a ten year period, the bill for local charges are expected to rise merely by 25% in nominal terms or by an average of half a dollar per year. Adjusting for inflation, this amounts to virtually no real dollar rise at all.

Although residential consumers are not expected to spend much money on such services as call waiting, call forwarding, etc., the rate of increase is expected to be quite high. A monthly total of $10 is expected to be spent on additional residential telephone services by 2007. This puts the rate of increase at 100% over the next ten years.

The combined local and long-distance bill of an average American family will reach $55 by 2007. This suggests that at the end of this decade, the long-distance part of the residential bill will grow just slightly faster than the local. With the opening of the long-distance market to new competition and competition from wireless, the Internet and the resources, long-distance rates will continue to be under pressure and margins are expected to drop further.

Adding the overall voice, data, and video services, an average per month American household is expected to spend $100 by 2007. Assuming 100 million households in the United States in 2007, the total voice, video, and data revenue generated in the residential market will reach $100 billion in ten years.

For business markets, the cost of voice communications for inter-city businesses is expected to drop by 5.5% in the short run, by 10% in the middle term, and by 15% in the long run. The competition not only from other wireline providers but from wireless and other alternative companies will force down the business rates offered by telephone companies.

RHC entry into the cable TV market is another extremely important issue. How much of the cable TV industry are RHCs expected to capture? Our experts believe that in ten years, RHCs will achieve 18.5% of the cable television market.

Competitive pressure will require further productivity improvements and cost reductions in RHCs. Experts believe that RHCs will reduce their work force by an additional 10% in the next decade.

Bell operating companies are expected to hold the major share of the residential U.S. local exchange market in the foreseeable future. Even though the interexchange carriers are readying to enter local competition, the chances that RHCs' market share will drop below 50% is zero in the near future and rises to only 15% in ten years.

Local number portability permitting American residential subscribers to move easily from one LEC to another is expected to penetrate 5% of the U.S. market by 1997, 20% by 2002, and 50% by 2007.

AT&T is expected to maintain its dominance over the long-distance market. Experts evaluate the odds of AT&T's long distance market share dropping below 50% as virtually non-existent in the short term but rising to 25% in the middle run and to 50% in 2007.

Wireless Market

Total revenue generated in the U.S. wireless market is expected to reach nearly $50 billion by 2007. Wireless communications is expected to constitute 35% of new subscribers for their voice calls at the end of the decade.

New users in the advanced nations are likely to follow the American trend, with 30% of new users expected to be wireless by the end of the decade. The developing nations are building their modern communications infrastructure over the next ten years. Experts predict that wireless transmission will constitute up to 50% of the voice traffic by the year 2007. The new users in developing nations, starting with a relatively primitive telecommunications infrastructure, may resort to wireless as an expeditious and economical system for voice telephone traffic.

A major issue in the U.S. wireless market is what will be the wireless medium of choice. There are, of course, several options known to us at this time and many more may be on the horizon. Digital cellular is now available. PCS is now a reality, and global satellite connections

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(e.g., Iridium) will be available in the next several years. Experts still believe that PCS will enter the market and will capture a 5% market share of all wireless traffic in the near future. This market share will rise to 35% over the long run.

PCS is expected to compete on price with cellular services and to position itself as the lower- priced cellular alternative. Experts believe that PCS services will enter the market with prices that are just about twice that of wireline. There is no doubt that wireless services will become more affordable, relative to wireline, over the long run with prices 40% above wireline.

The chances that digital cellular will lose as much as 25% of its residential market share to PCS providers received a 50-50 chance over the long run.

Cellular is expected to maintain its dominant market share in the "business on the move" market, at least through the beginning of the next decade. The odds that cellular will maintain at least 50% of its market share in this market drop to 50% by 2007. Hence, the doors are open to PCS over the longer period for it to penetrate the "business on the move" market, competing effectively against cellular.

Economic Impact of the U.S. Telecommunication Infrastructure

The economic impact of the information age telecommunications infrastructure will be immense, globally. The information age can only be compared with the industrial revolution. The telecommunications industry is one of the fastest growing sectors in practically every country and is expected to improve the U.S. GNP by 2%-4%.

Increased competition among service providers will lower rates, resulting in more usage. Convergence, leading to mergers, within the telecommunication and information technology sectors will set off a competitive war with some employment and displacement in the early stages followed by significant economic expansion as new technology leads to new applications and growth. Increasing global competition will force the less nimble companies to go out of business. Those effectively utilizing the infrastructure will be very successful.

The competitive position of the United States will increase, helping the U.S. gain larger market share on a worldwide basis. Since technology accelerates the pace of change and, in general, small business can change more quickly, small business growth and start-ups will continue. The ability to transfer data within and among enterprises improves collaboration between business partners, reduces cost, improves quality, decreases cycle times and time-to-market, and increases reliability of products.

Another explosive input to the economy will come with the consumer ease of access to more avenues for spending disposable income. This will be generated from the child who can play video games with friends outside home, to the shopper with virtual mail, electronic stores, and catalogs that provide personalized shopping.

Today over 70% of U.S. output consists of services. The information age will help to further facilitate growth in the services sector. Human resources required today to "hand-deliver" information will need to be re-educated and redeployed, much as steel employees and farmers were in yesteryear. The public will not use the post office to mail their bills when they can do it electronically, nor will they want to pay the local phone company for dial tone.

The significantly large SOHO (satellite office / home office) segment — with its need for videoconferencing, fax, personal computers, and telephones all in the home and paid for by corporations as business expenses — will help businesses save on office space with "time share" offices for employees. This will also help with child care and elder care responsibilities in addition to reducing commuting requirements, expense, and pollution.

The market for telecommunications infrastructure equipment will continue to grow, exceeding $300 billion by the year 2000. The services that will be enabled by the infrastructure will be in excess of $700 billion by the year 2000. Hundreds of companies will start to offer information products and services and millions of jobs will be tied directly to the telecommunications industry.

The new information age will further decentralize business to smaller communities outside of major cities, hastening the decline of urban areas. This trend will significantly reduce the cost of information, which will be seen more and more as a commodity. More information means less margins in competitive products, implying an overall positive impact on economic growth. This will result in greater diversity among businesses with fewer large corporations and many smaller niche companies.

Businesses which involve physical handling or transfer of information will be reinvented by on-line services. People and intellectual capital will be transferred more rapidly, creating vast wealth and further accelerating change.

Information technology will have implications for the development of a new tier of cottage industry businesses, and it will drive competition into broadband markets. New entertainment, distance education, and sports options will also result.

Today, telecommunications is becoming the key enabler for improving products, processes, and services; getting closer to customers; and generating new business opportunities. As information technology and communications converge, a new business model is beginning to emerge. It has four levels but is vastly different from the old industrial-age model (see *Figure 4*).

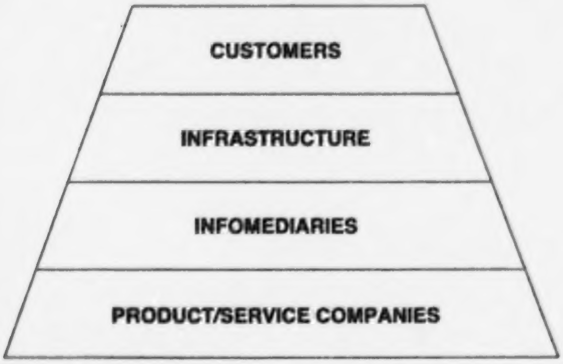

Figure 4. THE INFOBUSINESS MODEL

The base of the model consists of dynamic product and service companies. The next level is composed of organizations that collect, warehouse, manage, distribute, and broker information. These "informedaries" form a bridge between the market and the product and service companies. The third level is the communications infrastructure. The infrastructure is a network of networks and computers, originating from both public and private sectors. The fourth and highest level is the market. The new market is a demanding, sophisticated market of individuals seeking products and services customized and tailored to their unique needs.

The U.S. telecommunications infrastructure is obviously an integral part of the model, for it provides the ubiquitous interconnection between millions of producers and hundreds of millions of consumers. A fully broadband, interactive infrastructure will no doubt be an essential platform for the numerous applications that will fuel the engine of the U.S. economy into the next century.

Large productivity gains will take place in the information sector: communications, advertising, entertainment, software, education, medical diagnosis, and securities. Telecom will support the productivity gains in all these segments, enabling interactively, speedier distribution, and transactions, while facilitating decentralization and globalization.

Trade Impact of the U.S. Telecommunications Infrastructure

Advanced countries will have access to vast new markets that today may be economically infeasible to access. Once an infrastructure becomes available, it allows global access to consumers, resulting in an increase in trade volume. Information can be delivered to more people and more places. Intellectual services will be available from anywhere at any time. As the trade barriers fall, rate cuts will follow and the number of services provided will increase.

Businesses find immediate value in electronic commerce that will replace paper correspondence for price quotes, purchase orders, bills, electronic payments, and similar activities. Business around the world will move to seven-days, 24-hours for multinationals. The international marketplace will simply look much like today's domestic markets after one generation.

The telecommunications infrastructure with its advances in communications and transmission technologies will make international trade and investment easier and less expensive. Competitors who for years could not compete will now have an open playing field. This influx will force each and every company to perform better out of necessity.

As a result of the increasing global awareness of products and services, the rising ability to purchase, and the resulting higher demand, physical distribution challenges will emerge to keep up with the demand for increased worldwide access to all offerings will all emerge.

The positive gains in the U.S. national economy related to infrastructure enhancements directly contribute to improvements in the global business viability and efficiency of U.S. companies.

American telecommunication services and equipment suppliers will additionally be benefited in their global efforts through investments in the advanced domestic information technology infrastructure. Assuming these companies are not protected or subsidized, they should become leaner, healthier, and more enduring competitors, gaining advantages in technical as well as market power and scale.

The global information infrastructure (GII) will enable both American and foreign companies to extend their reach into all corners of the world. The GII will change the structure of the trade between nations as the basis of trade becomes the communication of content and transaction. Developing an electronic market in which highly developed information content can be both dynamically created and consumed will improve investment. The electronic marketplace will reduce physical barriers to entry, improving global competition. The GII will enable the United States to establish and enhance its position as the premier exporter of information content.

The new global information infrastructure encourages the development of information content, the global electronic information market, education and management consulting services, telemedicine, and entertainment, helping the United States to retain leadership in those areas. Exports in these areas will be stimulated. A large part of infrastructure will be software, and the United States will have a larger share of world markets. The United States will likely be exporting much of the computer and telecommunication technology.

On the manufacturing side however, there are two important issues. First, it is significant that many underdeveloped countries are transitioning directly from "primitive" modes to current technology, jumping over the intermediate stages. The Asian and South America countries will have the fastest growth rate of any countries for infrastructure development. Europe will be a major market. The former USSR nations and Africa, though still politically risky, will eventually become somewhat significant markets for telecom and information infrastructure equipment and services. Smaller localized companies in advanced countries will provide niche services unique to countries or regions while global companies will provide the basic infrastructure. This signals a significant potential for major players in the industry.

On the other hand, unless there is a turnaround in the U.S. manufacturing sector, a larger share of this infrastructure hardware will be furnished by Asian and European companies. Nevertheless, the United States will continue to dominate the technology arena.

Experts believe that the U.S. information infrastructure will have at least one major negative economic impact. It will increase the gap between the "haves" and "have nots". This gap will widen due to the financial inability of the underprivileged groups to acquire means of accessing the infrastructure and to be "hooked up" to the services available.

At the international trade level, the experts suggest a similar phenomenon will occur between the "have" and the "have not" countries. Developed nations will have access to and will be able to use their massive telecommunications and information infrastructure to improve their economic well-being and trade status. The developing nations on the other hand, will not be able to participate.

The global information infrastructure will simply increase the gap between the advanced economies and the less developed nations. Since the ability to produce at lower cost will be tied to both information technology and the infrastructure on which it rides, nations with more advanced "users" and structure will mostly benefit.

Societal Impact of the U.S. Telecommunication Infrastructure

While many positive outcomes are expected to flow out of the information and telecommunications infrastructure, experts point to a number of emerging negative societal issues as well.

The generation that is "plugged into equipment" will become more isolated and accordingly, ineffective in interpersonal skills. Ironically, the ease of accessibility and increasing telecommunication between all citizens will lead to a lack of social meeting outside the home.

Access to and an ability to use the technology will be a key factor for economic success. Neither access nor technology will be rolled out democratically and will depend on the financial means of various economic classes. Thus a potential widening of the gap between "have" and "have not" segments of society could result.

The information age will greatly equalize the information and resources available to both rural and urban populations. Nevertheless, it will generate a greater divide between the computer literate and nonliterate. Continued stratification of those who embrace communication/ information tools and technology with those who are "left behind" will create a virtual "class distinction," requiring another policy choice for governments: national information training.

U.S. society will expand usage of infrastructure for "blue" applications. Pornography and gambling will become the primary applications. Coping with these applications will become hotly contested social issues. This is already being seen in moves to imbed parental control technology in television sets and on-line services. As attempts at censorship and control of content fail, privacy will become even a more significant domestic discomfort factor. Monitoring or control of infrastructure use will become a national political issue.

We will see drastic changes in the way we live, learn, work, and play. Information will be readily available to anyone, anywhere. This will give birth to a new form of social debate: the "value systems" of future generations. Many companies will be primarily "work at home" companies. Everyone will have cheap devices for information retrieval and storage.

The drive for convenience will increase the demand for wireless solutions. People will have more free time to spend on activities of their choice, focusing on society, home, and family. This will be counterbalanced by increased competition, shortening business cycles, and employees involved in work 7 x 24 - seven days a week, twenty-four hours per day.

The "traditional" concept of job security will disappear. Security will have to come from within individuals and the way people will strive for it is through personal growth and development. The bottom line is that we, as individuals, will change because only the strong will survive. Education will be the key, as will self esteem.

Movement toward "the family" will be greater and the intellectual workforce will ensure that "blended" lives and adulthood are the norm and not the exception. The new thrust will be on ethics that in a global world will begin with information.

The environment will benefit significantly, especially in larger metropolitan areas with less pollution and smog. Reduced non-productive commute time and greater ease of commuting will result in fewer automobile-related accidents.

Another impact of the telecommunication infrastructure includes the increasing appearance of the "virtual corporation". With the advent of information availability whenever and wherever it is needed, the traditional workplace environment will be redefined. Work will be viewed more as a process and not as a place. The virtual corporation will be one in which employees and consultants will be indistinguishable. Employees who are comfortable with a constantly changing environment will be more inventive and prone to risk-taking, and they will have higher self-esteem. Employees who are comfortable with their skill-base and knowledge will not require long-term employment with one company.

The infrastructure, however, is simply a tool. Work processes and culture must change in order for the full impact of the infrastructure to be felt. Companies will have to transfer into flat, horizontal organizations in which groupware will be the bonding fabric. This will put the traditional managers in a position again as producers and not merely overseers. Pay for performance instead of pay for time in many positions may become the basis for compensations.

The social impact of the information and telecommunications infrastructure will be greater than the economic and trade impacts. People will be able to live where they wish and still have better access to good jobs, good and lifelong education, good health care, good entertainment, and better understanding of the world and the life enrichments that such understanding brings.

On-line and wired individuals, the youth in particular, will be very well informed with an increasing global perspective. Communication between people of different nations will become possible in a greater variety of media choices. Borders will be easily crossed and a more global-oriented human will develop, instead of the nation-oriented individual.

Executives are somewhat concerned about the societal impact that the information infrastructure will entail. Although the information age is expected to create much comfort for the working class and telecommuters and create a more global rather than parochial work force, it is also expected to cause a wider economic gap and generate greater social tensions between various social groups.

It is also expected to make parental control much harder and the censorship of unwanted material into homes more difficult. Whether good or bad, it will create a more individualistic society that will feel more comfortable teletalking than conducting personal conversations.

Telephone Companies Ten Years from Now

The regional holding companies, GTE, and the long-distance carriers will be in cable, entertainment, content, data, long-distance and local services. Smaller telcos will merge for economies of scale. Full-service, full-content, fully interactive organizations managing the vast majority of information and interaction with end users — emphasizing reliability, privacy, and total services — will emerge. They will also partner with content providers outside of the US, as one can already see the occasional BBC program on U.S. cable.

Most "plain old telephone service" (POTS) providers are in other lines of business today. In ten years a "POTS provider" will make less than 50% of its total revenues from wireline voice service, compared with more than 80% today.

Mergers, acquisitions, and partnerships crossing every industry line is a sample of what the future will hold. Bell Atlantic, Pacific Telesis, and NYNEX have formed a joint venture with Creative Artists Agency to develop new multimedia programming, while Ameritech, BellSouth, SBC, and GTE have joined with Walt Disney for the same purpose. NYNEX has invested $1.2 billion in Viacom. SBC Communications, Inc. has paid $650 million for the Houser Communication system in Maryland & Virginia. US West has teamed up with Time Warner and merged with Continental Cable in investments valued over $11 billion.

AT&T has invested $12.7 billion in McCaw Cellular Communications and has acquired a number of technology start-ups — including game maker Spectrum, Holobyte, and General Magic, which is a consortium with three cable companies to enter the wireless market. British Telecom and MCI have recently announced plans to merge. The new firm plans to spend $2 billion to build local loop telephone networks in twenty of the largest cities in the United States.

Sprint teamed with three leading cable companies to acquire a large position in PCS licenses. Bell Atlantic and NYNEX and Pacific Telesis and SBC have already begun their historical merger process. Although these major changes amount to $50 billion, they represent only the beginning of a major repositioning of the information industry. Mega-companies will dominate markets in transport, content, and appliances. It will be interesting to observe the strategies of the individual players as the competitive marketplace accelerates corporate positioning decisions.

Cellular Companies Ten Years from now

Growth of cellular penetration will continue well into the future even though the rate of growth will decline over time as the penetration level increases. Cellular companies will be full-service providers, offering digital technology with near-nationwide coverage. They will provide local and long-distance services, wireless local access, fax, and paging services and will be low-speed data transmitters and billing management integrators. They will have expanded more into advanced messaging and services that support businesses, virtual organizations, and people working on the move or from home. They will be in a highly competitive environment similar to today's local and long-distance companies whose price competition will be prevalent.

Cellular will be in direct competition with PCS and will be challenged to differentiate itself in the marketplace with competitive offerings, product packages, and service offerings. If cellular companies reduce price as a trade off for volume and effectively handle increased capacity, they may maintain their strong market share against the thrust of PCS companies.

On one hand, economics will continue to favor wireline for volume users. On the other, the intense competition that is expected with the implementation of PCS systems and even satellite will force mergers among cellular companies and between cellular, personal communication, and complementary wireline companies. Hence, the cellular-only companies may, by and large, become extinct. Rather, they will be a component of a full-service company (cable, POTS, and long distance). As stand-alone companies, they will serve very niche market markets and will not likely survive in the long run as telcos and cable companies enter wireless market.

Personal Communications Services (PCS)

The future of PCS services is perhaps more in doubt that any other area in the industry. Although billions of dollars have already been spent to acquire PCS licenses, the service is still unknown to the average potential American user. Furthermore, PCS is entering into an existing market that already has a number of wired and wireless alternatives with more on the horizon. These realities suggest that ten years from now, it is uncertain whether PCS companies will gain a substantial foothold in the wireless market.

Positioning the service and the device as the low-price alternative to cellular, PCS companies are more likely to develop the mass market for mobile services in 10 years. PCS providers can be the primary providers of what is now basic telephone service by trying to replace the wireline handset. Alliances with RBOCs, IXCs, cable companies, and CAPs will be completed in major markets, continuing in the second- and third-tier markets.

PCS companies will change wireless competition by introducing methods of packaging services, new features, and billing since they are implementing new primary and supporting systems that will be state-of-the-art and customer-focused.

Cable Companies Ten Years From Now

Telcos and long-distance companies have no reservations about their strong desire to enter the area of home content delivery in the near future. Cable companies, on the other hand, have plans to expand into other areas of the industry: telephone and data transmission in the broadband age. Cable companies are typically undercapitalized and individually hold a minority share of communications revenues.

To expand beyond their current role, cable companies have several choices. The most likely ones include: mergers and alliances with long-distance companies or local telcos, consolidation and alliances with other cable companies, or remaining "as is" in their current regions. Other than the external (e.g., deregulation) forces, three internal forces will determine the fate of cable companies: their lack of capital, lack of technology and infrastructure for growth, and lack of positive public image.

Only 3% to 5% of major cable-only companies are expected to remain in their current form. Others will be acquired. Cable-only companies will serve small areas of the country — mainly rural for video and low-end telecommunication services — competing primarily with satellite companies.

Cable companies are in the core business of delivering, entertainment, including video-on-demand over many channels. They are capable of leasing their facilities to other companies, such as CAPs and out of region LECs for use in providing true two-way communications including POTS.

Telcos are interested in acquiring or establishing cable companies in their own regions for easier entry into broadband markets. Opposition of the Justice Department may be an impeding factor only in the short run. Over-building wireline networks is too expensive a proposition today. Broadband radio technology offers telcos a relatively inexpensive alternative. Cable companies will also be owned by other companies — companies who want local-loop access.

- Cable companies will be in the process of "mass customization" to differentiate themselves from the direct broadcast satellite companies.

- They will upgrade their infrastructure to become one-stop multiple telecommunication and distribution companies providing telephony, cable television, interactive video, video-on-demand, home shopping, on-line/Internet access, gaming, smart home environment, telemedicine, and tele-education. Acting as "enablers" to other content providers, they will offer these services on a bundled or ‡ la carte basis.

- Cable companies will not only concentrate on the residential markets but will become global in reach, providing combined entertainment and communications services to homes and broadband facilities to businesses.

- Cable will emerge as a major competitor for commercial bandwidth applications and as a source of competitive services in the areas of residential electronic commerce, games, and Internet/World Wide Web access.

- Cable will ally as well as compete with telephone, wireless, and entertainment companies. Their contribution will be to stimulate consumer demand by broadband delivery of vast quantities of data to the home via coax and cable modes.

Conclusions

The next decade will see more change in telecommunications than most professionals have experienced throughout their careers. Technology, globalization, convergence, and competition will significantly impact all information industry corporations. Only those who effectively prepare for the changes ahead will prosper in the long term. It is hoped that the research results summarized in this paper will help to provide insights and stimulate executives, managers, and professionals who are stewards of corporate well-being.

1. "The Consolidation of the Information Industry - A Paradigm Shift," published by the International Engineering Consortium, 549 West Randolph Street, Suite 600, Chicago, Illinois 60661-2208, 312-559-4100 *(http://www.iec.org)*.
2. "*Telecom Outlook Report: 1997 - 2007*," published by the International Engineering Consortium and University of Southern California - Center for Telecommunications Management. IEC: 549 West Randolph Street, Suite 600, Chicago, Illinois 60661-2208, 312-559-4100 *(http://www.iec.org)*

Seamless Interconnection is the Key to Global Service Provision

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This paper is concerned with one of the main aspects of the current transition period in world telecommunications from monopoly arrangements to open competitive markets: the issue of interconnection and interoperability.

Users believe that it is essential that their views and needs should be taken fully into account now that plans are going ahead rapidly for the provision of global services. As we see it, the challenge that faces the industry is quite complex. On the one hand users, having won the general battle for liberalization from monopoly arrangements in many national markets, have no wish to find themselves facing a new style global cartel with a small number of consortia deciding what shall be on offer where, and under what conditions. But on the other hand the fact is that for years to come there is no prospect that any one global operator will be in a position to provide acceptable reach or quality of service in all the countries where the most modern communication facilities are essential. So ways have to be found that involve various carriers in providing services that are at once seamless and at the same time competitive.

How are we to achieve the seamless inter-operation of competitive networks and services? This is the theme that we need to explore, and that I shall endeavor to develop.

Background:

All telecommunications customers require the ability to interconnect with other customers in a seamless fashion in terms of function, facilities, services, standards and commercial arrangements.

The introduction of competition, which brings with it a wider range of services, better quality and lower price, must be accompanied by the preservation of this seamlessness throughout the world.

Interoperability between service providers is a high priority topic under consideration by the ITU. The ITU has notably streamlined its procedures. The efficiency of its standardization work has improved, and the benefit will also be felt of the liaison arrangements now established with the European Telecommunications Standards Institute and other fora. It is, however, still mainly an assembly of governments, and the mechanisms for dealing with international consortia present new challenges. The ITU has great influence and makes Recommendations, but as we meet today there is no single institution with a clear mandate to co-ordinate global network development - nor is it by any means certain that any such initiative would be generally welcome.

Within the European Union (EU), interoperability is recognized as a key factor in ensuring an environment of open and competitive markets. An EU Open Network Provision (ONP) directive has been drafted concerning harmonization and conditions for open and efficient interconnection with public network services. Notably however, this ONP directive excludes a solution to service interoperability beyond the scope of universal service and confines itself strictly to network interconnection.

Evidently in regard to the inter-operation of competitive enhanced services we are still, if not at the very beginning, at least in the early days of the story, and it is to this issue that I now turn.

First, so that we have this clear, I should say a word about definitions. Interoperability, (and here I quote from a recent paper of the International Chamber of Commerce) can have two general meanings: Foremost, it may refer to interoperability at higher levels of network functionality, i.e., affecting requirements between software programs residing on terminal

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equipment but not directly affecting the network itself. In this context, regulatory intervention is normally unwarranted and inappropriate. Interoperability of this kind is best left to the competitive marketplace to determine in response to market needs.

Alternatively, interoperability may refer to the essential interoperability accompanying interconnection of terminal equipment or other networks with the incumbent Telecommunications Operator's (TO's) network, i.e., public network to public network interconnection. In this context, interoperability is vitally important and becomes even more so as networks move to utilize digital technology. This is because terminal equipment must interoperate with similar equipment located in the TO's network. Thus, adequate and timely information must be made available to interconnecting networks and TO terminal equipment manufacturers addressing both interconnection to, and interoperability with, public network services.

This paper is concerned with Interoperability as it relates to inter-operation of competitive services… software programs residing on terminal equipment.

The Issue:

Multinational companies and individual customers need to use services without having to take into account the choice of supplier made by the other party or parties involved in the communications.

Freedom of supplier choice by communicating parties is inherent in the desire for open markets and fair trading. The exercising of that choice must not have a financial or functional penalty on others.

Using an example from the field of telephony, it would be unacceptable for someone telephoning the US from the UK to have to know which local, long distance or international carrier the called party was contracted to use. The carrier(s) may change at any time if the called party has a choice of inbound operators.

Alliances between monopoly operators are evolving to provide international and global services. Included services are those variously described as "Global Virtual Network Services" (GVNS). GVNS introduces an additional factor underlining the need for seamless interoperability without a penalty to customers.

It has been suggested that the laws of mathematics will determine that over time the number of successful global alliances will tend towards the average number of competing national operators in open markets.

This will arise because competing national operators will seek alliances with some degree of exclusivity on the part of both partners. This might imply that if there were 4 or 5 competing national operators in most open telecommunications markets of the world, there would be 4 or 5 global alliances. Each alliance would have a preferred relationship with one or another of the national operators in each country.

It will not be as simple or straightforward as this of course. There will be some non-exclusive arrangements. As of this writing, the alliances are not overlapping in terms of their partners; especially in situations where equity participation is involved.

This has another significant implication in terms of supplier choice. For at least a decade, it is likely that the original monopoly operator will have the largest national "penetration" in terms of home country coverage.

Highly distributed multinational customers, with multiple sites in each country, will likely prefer the alliance in each country which includes the original monopoly operator. The reason for this preference is service quality and penetration coverage.

This will not be the case in all circumstances. As competition develops, the delay before alternative providers have similar penetration may decline. Nevertheless it is likely, indeed unavoidable, that customers must have relationships with more than one alliance in order to achieve adequate coverage of service in all their operating countries. No alliance will initially operate in every country of the world.

Widely dispersed customers must therefore adopt a multi-vendor strategy.

Global customers have an unavoidable need for full interoperability between the services provided by each global alliance. They cannot accept functional and financial penalties as a consequence of this requirement.

There must be no significant barriers in terms of service quality, function or cost. This would impose the restrictions described above. It would be illogical, unfair and unsustainable to impose cost burdens or functional disadvantage on another party who has no control over the decision.

It is essential that competition evolves. As global alliances become licensed to provide national and international services in markets opening to competition, they must agree contractually to inter-operate with each other in a seamless fashion. Large customers will insist upon this in their contractual service agreements with these alliances.

Interoperability is a fundamental requirement for all customers of telecommunications services if the full benefits of competition are not to be severely damaged by large and separated supplier power blocs.

Progress to Date:

During June 1996, The International Telecommunications Users Group (INTUG) hosted an Interoperability Panel discussion between four of the worlds leading network providers: Global One, Concert, AT&T Unisource and Scitor. This may in the future be seen as an historic event in the development of that elusive balance between co-operation and competition which is so essential for an open market to serve customers effectively. The following indicate the main relevant issues raised at the meeting.

The emergence of alliances between major telecommunications operators in order to deliver "seamless" end-to-end GVNS has been a feature of the new competitive era. Seamlessness has proven to be a challenge for these alliances in data and voice services, even within their own "families".

A greater, but equally important, challenge is for service providers to address the issue of achieving the same goals between their various competing offerings as well. This is of course essential for customers operating in many parts of the world, who want to use the best supplier wherever they are.

Such global customers need to link up their operations without significant loss of functionality, and without cost penalties. They also need to avoid the confusion that would arise if one part of an organization making a simple change of local provider can cause havoc to the functioning and costs of another part of their organization somewhere else in the world.

Imagine if every time you changed your local telephone provider (for those who currently have a choice) you had to warn the rest of the world that it would cost them more to telephone you. It is bad enough having to tell people about number changes where there is no portability.

From the discussion it was clear that the lack of interoperability will be a major barrier to the development of competition and also an impediment to market growth. It could risk global lock-in to one alliance and price cartels between major players. This must be avoided. Unlocking accelerated market growth is a key motivator for service providers to invest in solutions to interoperability.

The aim of the INTUG panel session was to facilitate a market-driven discussion between suppliers and customers, and to agree to an action plan for further progress.

The Way Forward:

The way forward must be consistent with competition and choice, and must make commercial sense to service providers. The discussion was therefore about defining the business goals, establishing priorities, assessing resource requirements and developing a time scale for achieving progress.

The main functional requirements identified by the telecommunications customers at the meeting were:

- a shared data base to enable use of a common global numbering plan
- on-net to on-net call completion and billing (to calling party only)
- calling line identification (essential for international 800 call receipt)
- ring back when free between service providers
- full call center functions (recognized as the most difficult)

While the focus was on voice communications, it was stressed that the principles of interoperability applied to all forms of communication and that the industry would have to improve on the lowest common denominator approach; for example, the X.75 linkage between X.25 networks.

Although there are many complex technical issues to resolve, such as equipment standards, signaling, dial-plans, trouble shooting, etc., it was generally agreed that the issue was really a commercial one. Since the focus of each alliance varied in terms of their main target markets, the priority for interoperability might also vary.

The commercial issues identified included:

- customer ownership
- contract relationships
- global discounting
- ordering and invoicing
- transfer payments

A five-layer model for progressing the issue was jointly proposed by the telecommunications customers and network providers present. The following levels were identified to achieving GVNS voice interoperability:

Level 1 - basic call completion (largely achieved already)
Level 2 - on-net termination between service providers
Level 3 - basic billing / reporting integration
Level 4 - end-to-end service management between services
Level 5 - feature transparency (for an agreed set of features)

Summary:

Whether it is public switched voice telephony, closed user groups, point to point, or LAN to LAN; interconnection and interoperability is in demand by users around the world who are looking for new and cost effective options to reach trading partners, customers or consumers. For the telecommunications sector, interconnection and interoperability will have a major influence on competition, and on the degree to which this competition will be commercially viable for new entrants.

A follow-up meeting between INTUG members and major network providers is scheduled to take place later in the year. This will be reported on in summary form at the conference.

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Global Satellite-Based Personal Communications Systems: The National Policy and Regulatory Challenge

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Introduction

With the coming of the millennium, a plethora of next-generation satellite systems are in the final stages of development. Ranging from narrowband, non-voice (e.g. Orbcomm and GE Starsys) to mobile voice/low speed data (e.g. Iridium, Odyssey, Globalstar, Ellipso, ICO, ACeS and APMT) to broadband multimedia fixed satellite (e.g. Spaceway, Astrolink, M²A and Teledesic) systems, the implementation of these new technologies will have profound economic and social implications and, if the hype is to be believed, promise to facilitate the realization of the GII. Most of these next-generation global satellite systems have been licensed by the U.S. Federal Communications Commission and have been undertaken by U.S. based corporations. This, in turn, has led to concern in many countries that the FCC has become the de facto global regulator.

In response to such concerns, the International Telecommunications Union (beginning at its 1994 Plenipotentiary Conference) undertook an examination of the policy implications of these global satellite personal communications projects, with a dedicated conference, the "Policy Forum", held in October 1996. This paper examines how these global systems may transform traditional telecommunications services, the concerns of and policy implications for user nations and the national and transnational regulatory responses, with particular focus on the conclusions of the Policy Forum and its aftermath.

While there is little doubt that the next generation satellite systems and technologies will have a profound affect on the scope, diversity and availability of the emerging information economy, many administrations have voiced serious concerns regarding both economic and network by-pass of existing operators. Related issues include the social and cultural implications arising from the free-flow of information which these networks will support. Are governments in the Asia Pacific region likely to respond with open arms, suspicion or protectionist barriers?

Once the space segment component of the infrastructure has been licensed by a single country, the real battleground will center on the accessibility of the terrestrial infrastructure component. Namely, under what terms and conditions will nations permit the operation of these satellite systems? How open will national markets be to the importation, ownership and use of the earth station terminals? What are the impediments to certification and type approval of these terminals and what are the prospects for a unified regional/global approach to overcoming these hurdles? Under what terms and conditions will the global operators be permitted market access to individual nations and how will interconnection to existing public networks be authorized?

The ITU Policy Forum

The Policy Forum was held in Geneva from 21-23 October 1996. It was attended by 833 delegates representing 129 Member States and 70 Sector Members. Although entitled "Policy and Regulatory Issues Raised by the Introduction of Global Mobile Personal Communications by Satellite (GMPCS)", the Forum took a broad view of the common issues applicable to all satellite systems (i.e. fixed and mobile, broadband and narrowband, global and regional, existing and planned) providing telecommunications services directly to end users. Historically, satellite systems were gateway-to-gateway, with national PTTs owning and operating the gateways and controlling the traffic, revenues and information flows. In contrast, the new GMPCS systems, while also offering gateway access to the PSN, are primarily user-to-user systems decentralizing the network intelligence and architecture and allowing bypass of the traditional network interfaces.

From this perspective, the Policy Forum considered a common set of policy and regulatory issues raised by the following kinds of satellite systems:

(a) existing and planned global and regional satellite systems providing mobile personal communications voice and low-speed data services and operating in the geostationary orbit (GEO MSS) ;

(b) existing and planned satellite systems operating in non-geostationary orbits and providing mobile narrow-band services, excluding voice, on a global or regional basis (i.e. "Little LEOs" or "Little" NGSO MSS);

(c) satellite systems planned to come into operation in the next two to five years in order to offer narrowband mobile services, including voice and relatively low-speed data, on a global or regional basis and to operate in non-geostationary orbits - including Low Earth Orbits (LEOs), Medium Earth Orbits (MEOs), and Highly Inclined Elliptical Orbits (HEOs) - (i.e. NGSO MSS);

(d) satellite systems planned to come into operation in the next five to ten years in order to offer fixed and transportable, multimedia broadband services on a global or regional basis and to operate either in geostationary or non-geostationary orbits (GEO and NGSO FSS).

The Policy Forum recognized that in spite of their different technical characteristics and different service offerings all of these systems share certain characteristics that distinguish them from traditional intergovernmental organizations providing satellite services, give rise to essentially similar policy and regulatory issues and, therefore, should be accorded similar policy and regulatory treatment.

The Conference issued five "Opinions", ten "Principles" and proposed the "Establishment of a Memorandum of Understanding to Facilitate the Free Circulation of GMPCS User Terminals." Opinion One, invited national policy makers and regulators, GMPCS system operators and service providers and users to "work co-operatively within the ITU to facilitate the early introduction of GMPCS."

Opinion Two, while recognizing the sovereign right of each government to regulate its telecommunications, set forth a set of "voluntary principles" to assist national policy-makers and regulatory authorities. The Principles called for:

- Early introduction of GMPCS services ("to allow people everywhere to share in its benefits");

- International Cooperation (particularly relating to user terminal licensing and free circulation);

Global service availability (realized by simplified regulations and practices);

- GMPCS Regulation (simplified, non-discriminatory and transparent regulatory environment particularly for service licensing, gateway authorization, interconnection arrangements and user terminals, "fostering worldwide competition for the provision of services and equipment");

- Investment Participation (encourage wide equity ownership in systems and services);

- Unauthorized Use (systems should turn off operations in any country which has not authorized the service);

- User Terminal and Free Circulation (develop multinational arrangements to achieve compatibility in terminal approvals, facilitate unrestricted international circulation of terminals and global roaming);

- Universal Access (provision of basic telecom services in rural and remote areas by GMPCS and gateway operators only charging at "reasonable cost");

- Interconnectivity (between GMPCS and public networks to enhance the availability, quality and profitability of services and facilitate the provision of universal service and competition); and

- Further Cooperation (national policy-makers and regulatory authorities, GMPCS operators, service providers and manufactures to facilitate coordinated solutions for the full implementations of GMPCS).

Opinion Three invited the three ITU Sectors to conduct studies to facilitate the introduction of GMPCS. Opinion Four set forth a draft MOU to facilitate the free circulation of GMPCS user terminals and established a timetable for its implementation. Proponents of GMPCS have expressed the desire that (except for normal interconnect and service charges) tariffs, custom duties and licensing fees should be minimized or even eliminated, in order to reduce impediments to transborder use and to accelerate the early introduction of GMPCS. The Conference recognized that the possibility of being able to operate GMPCS terminals without geographical constraint is one of the most attractive features for potential users but "raised regulatory concerns". Beyond the traditional concern of national regulators that the use of GMPCS terminals should not cause harmful interference to other radio equipment or harm to the telecommunications network, regulators are concerned by the lack of developing country participation in the ownership of GMPCS and, most importantly, the threat that unauthorized use of GMPCS will result in significant by-pass of the PSN with a resulting loss of revenues.

Therefore, the Forum concluded:

(a) that free circulation of user terminals needs to be considered at three levels:

1. permission to carry a terminal into a visited country but not to use it;

2. permission to carry a terminal into a visited country and to use it without the need for obtaining authorization in the visited country, in conformity with Principle 6 of Opinion No. 2 (Unauthorized Use); and

3. technical conditions for placing terminals on the markets.

and that free circulation should be in conformity with the laws and policies of the country, and should be limited to the GMPCS systems authorized in the visited country;

(b) that, as defined above, free circulation involves some matters that are normally within the competence of telecommunication regulators and others which are of the competence of other government departments;

(c) that to facilitate levels 1 and 2 of free circulation, there may be a need for arrangements between custom administrations in order to facilitate custom clearance for users intending to use their terminals in the visited country or transiting to another country;

(d) that to facilitate level 2 of free circulation, it will be necessary to reach arrangements on the mutual recognition of type approval and licensing of terminals;

(e) that to facilitate level 3 of free circulation, it will be necessary to reach arrangements on mutual recognition of type approval of terminals;

Interested parties were invited to submit comments on the draft MOU by 31 December 1996, and an "informal group" of governments, operators and equipment manufacturers are scheduled to convene in early 1997 to consider the comments and improve the MOU. Later in the first half of 1997 the ITU will host a meeting of intended MOU signatories to work on agreements relating to the free circulation of terminals, with the intention to complete the initial arrangements by 1 July 1997.

Finally, Opinion Five focused on the implementation of GMPCS in developing countries and expressed the concern that the charges for access and utilization of services may be too expensive for most developing country citizens. Therefore, system operators are urged to provide "some capacity at reasonable cost" and gateway operators are urged to offer "transport tariffs at reasonable cost" in order to contribute to the attainment of universal service in rural and remote areas of developing countries.

The ITU Bureau for Telecommunication Development (BDT) was asked to prepare, by July 1997, a checklist of factors which developing countries may use in the process of introducing GMPCS services. The BDT was also asked to establish a group of experts to conduct studies on technical and regulatory issued and prepare a report to the next World Telecommunication Development Conference in 1998.

Conclusions and Analysis

The Policy Forum concluded with broad consensus in five key areas:

- the role of GMPCS in the globalization of telecommunications;
- the shared vision and principles for GMPCS;
- essential studies by the ITU to facilitate the introduction of GMPCS;
- establishment of a Memorandum of Understanding to facilities the free circulation of GMPCS user terminals;
- implementation of GMPCS in developing countries.

It is the opinion of the author that although market forces and technological advances are the primary drivers in the telecommunications field, the single most important element in determining the availability of effective communications services is national regulations. Because regulation has always been viewed as solely a matter of national sovereignty, the various, and sometimes incompatible, national regulatory regimes have operated to impede the rapid deployment of new networking solutions. To this end, the convening of the Policy Forum to address and rationalize common global regulatory solutions to impediments confronting the satellite industry was a radical and refreshing initiative. Moreover, the broad concensus reached at the meeting is a bold first step toward opening national markets and fostering a global competitive marketplace for GMPCS.

At stake is not just the fortunes of the handful of private companies which are investing billions of dollars in these new GMPCS enterprises. Because these new generation systems will ultimately provide a wide range of narrow and broadband communications services at any time, in any place, everywhere in the world, their availability at reasonable prices without burdensome regulatory constraints are of universal interest. Transnational and global enterprises such as broadcasting, transportation, tourism, energy, agriculture, forestry and mining industries are anticipated to be early beneficiaries of GMPCS.

GMPCS services, if they are affordable, will bring benefits to regional and international organizations that operate "without frontiers" and will be particularly beneficial to countries that have large land masses in relation to their population or which have poorly developed terrestrial telecommunications infrastructures. Organizations which employ GMPCS are expected to have increased efficiency, productivity and competitiveness. Nations which do not impose undue burdens on GMPCS systems are likely to have indirect economic benefits through increased investment, employment and exports. Finally, GMPCS will aid in extending governmental and social services including education and medicine to rural and remote areas.

Against this background are the traditional regulator/ PTT concerns of sovereignty and control. By obviating the need for most large gateway earth stations in favor of handheld or transportable terminals, GMPCS systems are viewed by some governments with suspicious or worse. Nevertheless, it is difficult for even the most control oriented policymakers to rationally object to the potential benefits of GMPCS.

The Policy Forum concluded with most of the right words and few of the usual national reservations. This is particularly heartening given the fact that the WTO negotiations on a basic telecommunications services agreement is set for conclusion in February 1997 and market access for satellite services are a prominent component of that trade agreement. Thus, for the first time the telecommunications regulatory and trade policy issues are squarely joined from both the telecom (ITU) and trade (WTO) perspectives. The timing is right and the momentum is there. The real test, however, will come when the first of these systems is up and operational. Then, the question will be whether these global systems will be permitted - from both a regulatory and trade policy perspective - to offer their users seamless communications, global availability of services and market access and thus, the next step toward achieving the goals of the GII.

DirecPC^{TM}; Worldwide High Speed Content Distribution

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Abstract

DirecPC is a **service**....both for Information Providers and subscribers. It is a hybrid high bandwidth service, able to be used in networks that are private in nature, while also delivering more publicly targeted information. In addition, it's users may vary from large organizations to individual consumers. DirecPC service is now available everywhere in the U.S., Canada, Europe and Japan.

Introduction

Because of the broadcast nature of the DirecPC, it can offer a reliable high bandwidth solution to its subscribers. The currently available services are Digital Package Delivery, Multimedia, Turbo Internet, and the basic Service Access (current news, financial and sports information).

The Turbo Internet DirecPC service is more than three times faster than basic rate ISDN. This wider "pipeline" speeds up the interaction with the Internet, and can download large media files, and streamed video, audio, and text. Turbo Internet is a service used primarily by consumers and Small Office/Home Offices (SOHOs).

DirecPC also handles closed network requirements for transmitting streamed information (DirecPC Multimedia) and content delivery in a file format (DirecPC Package Delivery). The primary users of Digital Package Delivery and Multimedia are closed group private networks. These private networks are created by businesses, government, education and other large user communities.

DirecPC service is implemented at the subscriber with a receive-only satellite antenna, adapter card, for PC or server, DirecPC software, and the subscribers dial-up modem. The service is provided from a Network Operations Center. The Network Operations Center consolidates the different sources of traffic for Package Delivery, Multimedia, and Turbo Internet, and transmits this over a satellite link to the subscribers.

Package Delivery Service

Package Delivery utilizes a high speed digital broadcast channel to send information directly to the remote users subdirectory on their hard drive. Information may be sent to standalone PCs or servers. These broadcasts are scheduled by the information provider. They may be sent on-demand, or on a pre-scheduled basis.

The scheduling of broadcasts optimizes the cost of transmissions. It accommodates the growing need in all telecommunications sectors for distribution of large digital objects on an occasional basis. This need manifests itself most prominently in the use of CD-ROMs to disseminate private content within organizations. CD-ROMs have become popular in this application because there is no affordable telecommunications alternative to both enable the movement of large content occasionally and, to have this content available immediately in a PC or server.

Package Delivery also meets the requirements that are desired but not often implemented by private CD-ROM producers. Most producers of private CD-ROMs must content themselves with one product for an entire organization. There is no room for modification to address the needs or concerns of sub-groups, and updates to content must wait until the next production cycle. Package Delivery allows modification of content down to the individual PC or server, and information can be updated immediately.

These are "delivery" options that an information provider can select when using Package Delivery. Package Delivery is a "push / pull" method of transmission. Content may either be pushed out of the DirecPC Network Operations Center by the information provider, or pulled in by a subscriber.

Push - Content is "pushed" out as a scheduled broadcast. The time of broadcast, the receiving locations, and the subdirectory at the receiving location is set by the information provider. The subscriber does not request the package, the only requirement at the receiver is to have the PC or server turned on.

Pull - Content may also be pulled in by each subscriber. Requests for Package Delivery content is made from the Package Explorer screen at the users interface. The request is made via the PCs or servers dial-up modem to the Network Operations Centers Package Delivery servers. Different types of content "pull" are used;

Periodical - Comparable to a magazine subscription. It is content scheduled to be transmitted on a periodic basis, similar to a print magazine or newspaper.

Selectable - This places the content on a carousel, where it will be transmitted at the time selected by the information provider. When a subscriber selects the content they are added to the scheduled distribution list.

Requestable - The content is placed on the Package Delivery server, but is not regularly scheduled for broadcast. It is transmitted upon request by the subscriber.

When Information Providers are using a broadcast, receive-only service such as DirecPC Package Delivery, they need some certainty that their content has been delivered to their target subscribers. DirecPC offers different levels of assurance.

Best effort - A standard transmission of content that requires no other interaction with delivery locations. DirecPC offers a 99.5% delivery success parameter for best effort.

Re-transmission request (manual request)- Allows any subscriber on the broadcast list to request a re-transmission of content that has been received in error. The subscriber simply "double-clicks" on the icon associated with the content on the Package Explorer page. The subscriber site software then requests the Network Operations Center to retransmit those frame in the file that were corrupt upon receipt.

Delivery confirmation (automatic request) -
Automatic request is available in either a positive or a negative confirmation.

In negative conformation those sites that received part of the content in error will automatically dial back to the Network Operations Center to request retransmission of the frames received in error. Positive confirmation uses negative confirmation and in addition, every subscriber on the broadcast list transmits (via phone line) a confirmation of delivery of the broadcast object.

Multimedia Service

DirecPC Multimedia service is a streaming content transmission service. Typical applications are video, audio, or text, from live sources, tape or disk. Multimedia allows content providers a fixed duration transmission which allows them to scale their broadcast and most importantly, only pay for bandwidth utilized. The destination of the multimedia content may be the PC, server, or TV monitor for business television.

Multimedia content is distributed within the DirecPC conditional access system. This provides for secure transmission of information to prevent piracy of software or disclosure of a private information.

DirecPC Multimedia Service content transmissions differ from Digital Package Delivery in several areas: Transmissions may be fixed duration, set by the content provider. Transmissions may be dynamic, in real time.

Transmissions may be a continuous stream of audio, video, or high speed data.

Turbo Internet Service

By far, the greatest interest in DirecPC is with its high speed Internet access, the Turbo Internet service. Turbo Internet users have Web browsers or newsgroup/bulletin board viewers that, save for the increased speed of Turbo Internet, operate no differently than with any other type of Internet connection. Turbo Internet uses a dial-up modem connection to an Internet Service Provider for requests into the Internet. Responses from Internet sites are forwarded through the Network Operations Center, over the satellite, to the subscriber.

A standard, local dial up connection to an Internet Service or Access Provider is used. Both SLIP (Serial Line Interface Protocol) and PPP (Point to Point Protocol) are supported for this connection. Subscribers run a version of the TCP/IP protocol in a separate "stack" if they are not using Windows95 with its TCP/IP software.

The DirecPC Network Operations Center is connected to an Internet Access Provider by high speed terrestrial lines. Inquiries in the Internet are in the outbound direction (from the DirecPC equipped PC or server via dial-up SLIP or PPP) to the Internet, and in the inbound direction are received via satellite from the Network Operations Center. So that the DirecPC users may receive information from the Internet at a very high rate, the Network Operations Center spoofs the Internet Access Provider and provides a larger, more effective TCP window size.

Access services

DirecPC service operators may implement a set of basic services known as the Access services. The access services contain "free" content to the subscribers. Free content may include news, financial and sports information.

Security

DirecPC uses DES encryption for the conditional access system. The use of

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a conditional access subsystem is most important in closed user group communities, where privacy of data transmission is of paramount importance. The encryption keys are software based, and may be easily changed. Keys are updated via the dial-up modem in the subscribers PC or server.

Service Architecture
The DirecPC service addresses both closed user groups and the open Internet community. Closed user groups require the appropriate connection to the Network Operations Center to reflect the urgency of the content that they are transmitting. All Multimedia streamed information that is sourced outside of the Network Operations Center typically require a dedicated terrestrial or satellite link. Package Delivery information that needs to be transmitted in a short amount of time (hours), would also likely require a dedicated connection. If the Package Delivery content is to be transmitted within the next day, receiving the content on disk, tape, CD-ROM, or FTP over the Internet would suffice.

The subscribers connection for Turbo Internet is via a local Internet Service or Access Providers point of presence. The requests from the subscriber pass through the Internet Service Provider to the Network Operations Center. The Turbo Internet Gateways at the Network Operations Center then pass this request to the Internet site of interest. The response from the site of interest is sent back to the Turbo Internet Gateway at the Network Operations Center. This response is mapped to the requesting subscriber site, broadcast over the satellite link, and decrypted by the requesting location. Response speeds of 400 kbps are typical under good conditions. Good conditions imply a high speed connection from the Network Operations Center to the Internet host in question and is limited by the slowest link within the Internet. Good conditions also require the use of the minimum recommended PC platform with windows options appropriately tuned for high disk-write performance as recommended by DirecPC.

The DirecPC Access Kit
The DirecPC Access Kit, or DAK consists of a receive-only satellite antenna and LNB, ISA adapter card for the PC or server, and DirecPC software. Ku and C-band antenna/LNBs are used for DirecPC service. High power satellite transponders allow for smaller subscriber antenna sizes.

Operating system software supported by DirecPC include Windows95, Windows 3.1, and OS/2 for the PC version. The server version supports WindowsNT, Novell NetWare, and Linux. In the WindowsNT and NetWare versions the client user interface is similar to that of the standalone PC user interface. The OS/2 and Linux operating systems are typically implemented without PC monitors, since they are typically used in kiosk and audio/video server applications.

There is a minimum PC configuration for running DirecPC. This is a typical multimedia capable PC with Pentium 75 Mhz processor, 16 Mbyte RAM, and at least a 9600 baud modem. The DirecPC application itself requires 20 Mbytes of disk space.

DirecPC Intranet Applications
DirecPC can immediately address the Intranet requirements of organizations by cost effectively moving content from site to site. The server version of DirecPC extends the benefits of DirecPC Multimedia, Package Delivery, and Turbo Internet beyond the single

desktop to clients that are attached to the LAN segment holding the DirecPC server. Use of private corporate networks, the Internet, or a hybrid of both may be used by organizations in implementing an Intranet use of DirecPC.

Intranet use of DirecPC may be used to meet user demands for high bandwidth media applications at every location in the corporate network. It may also be used to cost effectively delivery high quality MPEG1 video or audio to both internal and external destinations.

DirecPC for Distance Learning
When coupled with distance learning software packages, DirecPC can offer simultaneous live or stored streamed video, audio, or text to multiple locations. The DirecPC service can be used to "narrow-cast" to select subscribers to gain the advantage of large groups when the subject is of interest to small communities that are geographically dispersed.

Summary
DirecPC is the world's fastest, lowest cost and most widely available access for a multitude of services, ranging from interactive and broadcast Internet applications to distance learning for closed groups. It is the solution for rapidly and inexpensively upgrading the telecommunications infrastructure to meet the immediate needs of customers worldwide for high bandwidth content communications for private and public use.

Implementation of the Palau Telecommunications Undersea Network

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1. ABSTRACT

The Island Nation of Palau will soon enjoy the high capacity and quality provided by their newly installed undersea telecommunication network. Island nations of the Pacific can benefit from the experience gained during the installation and implementation of the Palau National Communications Company inter-island fiber optic system. The turnkey operation encompassed the provisioning of network and transmission equipment, outfitting and installing containerized cable stations, equipping and delivering an installation/maintenance boat, and performing the system installation operation. The unique installation challenges and corresponding innovative solutions that were developed are described to act as an aid to other island nations seeking high quality telecommunications connectivity.

2.0 OVERVIEW

The Republic of Palau is an island nation of approximately 14,000 people located 800 miles southeast of Guam. It consists of virtually hundreds of islands, with the three principle ones being Koror, Babeldaup and Peleliu. Palau's population is diversely distributed among the shorelines of these three islands with primary access to many population centers being by boat. The Palau National Communication Company (PNCC), recognized the need for having high quality communication delivered to its inhabitants and thus embarked on the ***Lightnet 2000*** program(1). An engineering study that addressed various alternatives for achieving telecommunication connectivity around Palau revealed that an undersea fiber optic network was the most cost effective solution. On October 12, 1995, AT&T Submarine Systems, Inc. (SSI) was awarded a contract to supply this network.

The Palau Undersea Fiber Optic Network(2) is a submarine/terrestrial cable system consisting of approximately 100 kilometers of submarine cable around the main island of Babeldaup with an additional 50 kilometer segment connecting the island of Peleliu (see FIGURE 1 for nominal configuration). At 12 of the 13 landing points there are containerized cable stations that house all the transmission and powering equipment. Approximately 80% of the cable route is inside a barrier reef in extremely shallow water. An additional 50 km of terrestrial cable was installed to complete the fiber loop around the island connecting the beach man holes to the containerized cable stations.

The optical network is essentially a physical ring topology except in the case of the link between Koror and Peleliu which is a "flat ring" section (both sides of the ring in the same cable segment). Each fiber pair (3 pairs in the submarine cable) in each of the segments will operate at SONET OC-3 (155.52 Mb/s). The SONET architecture and the ring configuration assure continuous operation even in the unlikely event of a cable fault.

2.1 THE NEED

In PNCC's ***Lightnet 2000*** mission statement it states that it shall:

> *"Integrate Palau into the global telecommunications network for the long-term economic well-being of the People and the Republic of Palau"*

With this as its goal, PNCC took to achieving a 21st century telecommunications system by first developing its infrastructure. While this is no small task, even for highly developed countries, it is much more daunting in a developing island nation with little in the way of existing infrastructure. The challenge was to connect populated areas in remote locations on the big island of Babeldaup along with the highly populated island of Koror and also the remote island of Peleliu.

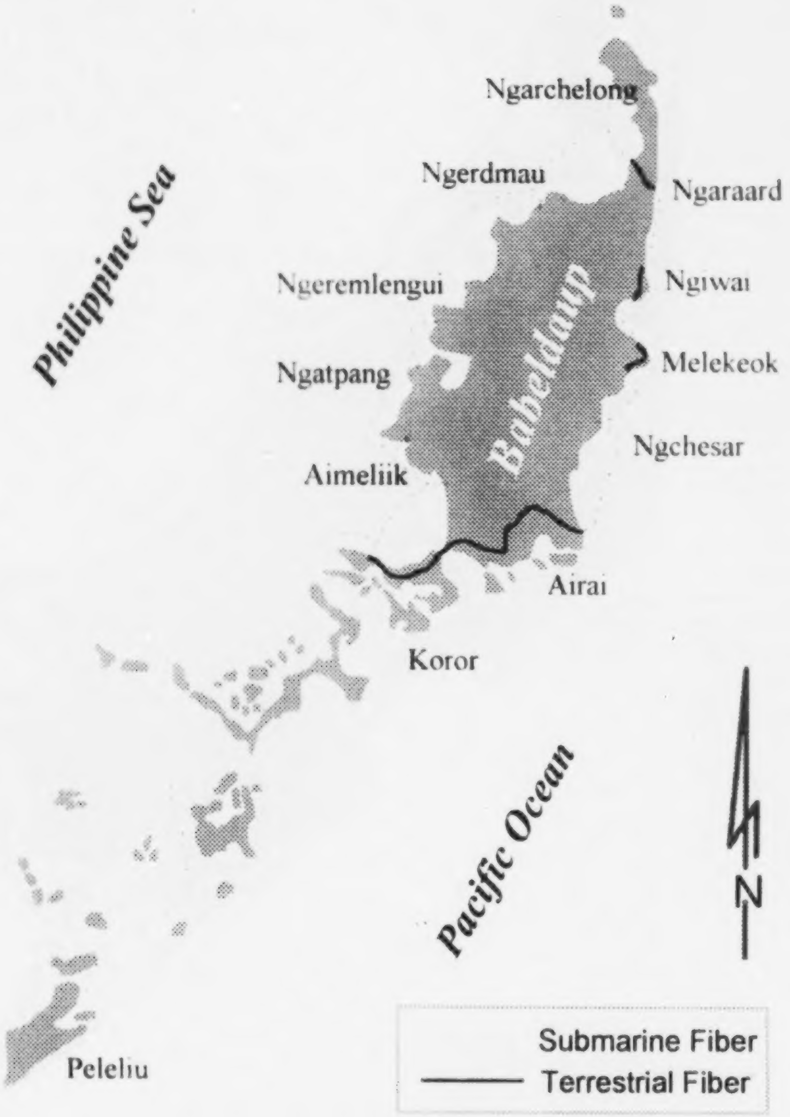
Ngarchelong
Ngerdmau
Ngaraard
Philippine Sea
Ngeremlengui
Ngiwai
Babeldaup
Ngatpang
Melekeok
Ngchesar
Aimeliik
Airai
Koror
Pacific Ocean
N
Peleliu
Submarine Fiber
Terrestrial Fiber

Figure 1 - Palau Undersea Fiber Optic Network

PNCC considered alternate means for achieving connectivity including: cellular, microwave, aerial, and terrestrial buried systems. The result of their analysis was that the sea route provided the most cost effective, highest quality solution for connecting all the desired remote population centers. An important driver of this result is the status of Palau's infrastructure - roads and power distribution in particular.

2.2 CHALLENGES

For a majority of the desired sites, land access was marginal and central power or other aerial connections were nonexistent. The landings in Palau were in many instances, virgin territory. While Palau is known for being a beautiful Pacific Island nation, the sites required for connection were not directly inland from open beach areas. More often, sites were quite challenging being within shallow lagoons or behind mangrove groves, or at other sites with limited sea access.

The Palau project represented a radical departure from a typical submarine cable installation. The system is all in shallow water, very short in length and has numerous shore landings. The remoteness of Palau itself, and also of its shore landing points within Palau provided significant logistic challenges. Furthermore, this remoteness required that PNCC be self-sufficient and fully capable of system operation and maintenance after system commissioning. Therefore, the resulting solution needed to be easily operated and maintained by new users of such hardware.

The environment in Palau was an important factor in the implementation. Since the installation occurred during the rainy season, numerous problems with electrical equipment arose making both vessel and beach cable splicing operations difficult. The greatest difficulty occurred with over land transit. Figure 2 illustrates a typical access road having large ruts and adverse slopes. The torrential rains that occurred and the drastic elevation changes on the unpaved roads made them impassable for much of the time. Often, boat transportation was resorted to as being quicker and more reliable.

3.0 SYSTEM SOLUTION

Because of the interdependencies of the various elements of the project, a total system approach was applied. FIGURE 3 serves to illustrate the key factors addressed during the design and implementation phase to develop the optimal solution. Attempting to design one aspect without considering its effect on others could have prevented a successful installation.

The system approach can be illustrated using cable selection as an example. The selection of cable size and type and the extent a particular type was used on a cable segment was determined by considering: the cable safety when on the bottom, the mechanism for delivering the cable to site, the methods for mobilizing on site and the configuration of the deployment boat with its associated installation equipment. All these variables were considered with key drivers being cost and schedule minimization.

It can be seen that as cable size increases boat cable capacity increases which could lead to a deeper draft vessel which may have prevented the use of the boat in some of the more shallow sections. With this in mind, a good balance was struck of all the parameters leading to the present selection of cable sized, its use, and the boat configuration.

Another example illustrating the value of the system approach is the decision to load the cables into pans on the boat rather than deploy them off a powered reel stand. Reel packaging of the cable in the factory for subsequent shipping proved to be most cost effective and reliable solution for getting cable to Palau. The use of a powered reel stand to deploy the cable was an obvious choice. However, on further investigation, it was determined that the reel stand would have been much more expensive than a cable engine deploying from pans. The reel approach would have required special reels, would have made shallow water slack control difficult (inertia considerations of large reels) and would have required a larger boat to accommodate the additional weight. Also, the cost of loading into pans on site was less expensive than building individual pans for factory load and transport. Thus, for the parameters of this project, reel shipment and pan boat stowage was the optimal solution.

4.0 INNOVATIONS

It should be apparent from the preceding discussion that the Palau system requirements were quite challenging and often conflicted with one another. This fact, along with a goal of minimizing project cost and schedule, leads us to develop several innovative solutions. These include: a custom

FIGURE 2 - Site Challenges

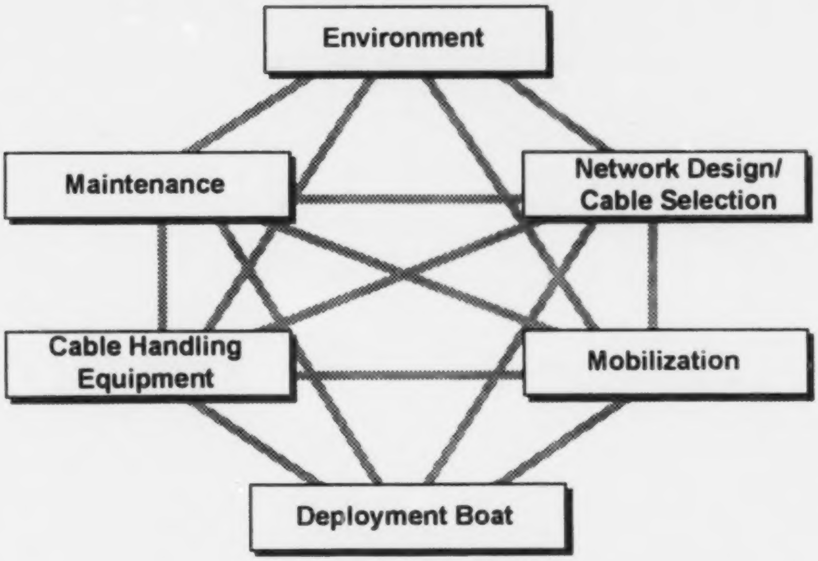
Environment
Maintenance
Network Design/ Cable Selection
Cable Handling Equipment
Mobilization
Deployment Boat

FIGURE 3 - DESIGN INTERDEPENDENCIES

design, shallow draft cable installation/maintenance boat complete with fiber optic jointing equipment, special deployment procedures to meet the unique site parameters, and containerized cable stations with hybrid diesel/solar power for remote operations.

4.1 INSTALLATION/MAINTENANCE BOAT

While the Palau project is on a much smaller scale than traditional operations, the facilities required for the installation boat needed to have many of the same functions of the traditional cable layers. FIGURE 4 illustrates two traditional types of cable deployment ships from which the functional requirements of the Palau boat were derived.

The functions available in the larger cable installation ships include(3): cable storage, cable machinery, overboarding mechanisms, positioning systems, jointing, mobilization methods, and boat control. In addition to these, the Palau boat has some post mission requirements such as vehicle equipment and personnel transport along with the cable maintenance requirements.

To minimize installation costs and to be able to satisfy the requirements for subsequent system maintenance, a combination installation and maintenance boat was developed. This multi-function boat was designed to perform all the installation functions and then, be turned over to PNCC for its subsequent maintenance operations.

The Palau boat (FIGURE 5) was designed by AT&T SSI. A SeaArk Marine work boat hull design formed the basis of this design resulting in a 46'x14'6" boat capable of carrying 260 cubic feet of the Palau SPA cable or 200 cubic feet of the SA cable (20,000 lb. limit). The boat is powered by twin 220 hp diesel/outdrives and has a full load draft of less than 3 feet. The final boat design was the result of engineering tradeoffs made among parameters such as cost, capacity, draft, sea keeping, maintenance requirement, and ease of conversion between cable layer and general transport. The boat will support PNCC in its normal operation and maintenance functions where the boat will be used to transport vehicles, fuel equipment, personnel, etc.

4.2 INSTALLATION PROCEDURES

The installation operation for Palau was labor intensive. The marine installation crew was made up of three AT&T SSI personnel (Engineer-In-Charge, Cable Engineer & Shore End Engineer), a navigator, a boat operator and a crew of 5. Typically, the Shore End Engineer and one crew member would transit behind the main cable laying vessel in a 16' outboard. When near the landing point, the Shore End Engineer would guide the cable boat to the best landing point and the cable boat would moor or anchor as appropriate. After landing and anchoring the shore end, the cable boat would lay cable to the next landing point and repeat the landing procedure. Because of the shallow water, it was frequently necessary to tow the cable boat with the 16' outboard, and in some cases push and maneuver the cable boat by hand. The shore landings were typically "all hands" evolution, with everyone except the boat operator and owner's representative getting into the water to handle cable. Because most of the shore manholes were not yet installed, the cable ends were simply anchored and the splicing would take place later. Fortunately, after site preparation which had its difficulties, most of the landings went quickly, seldom taking more than an hour to complete.

The cable loading was done by a different crew, after the boat returned from laying cable. As mentioned, the cable was transported to Palau on large reels with each segment having its own reel. The reels were placed on a non-powered stand and the cable was loaded into the cable tanks on the installation boat. This was a labor intensive and time consuming process having an average load speed of approximately 1 kt.

4.3 CONTAINERIZED CABLE STATIONS

The containerized cable stations (FIGURE 6) were specifically configured for this project. They serve to house the transmission equipment, power supplies, distribution panels, and in some cases generators. On their roofs or to one side are secured solar panels. Prefabricated containers were selected for the project because they provide low cost, high quality, quick installation, and commonality of equipment and configuration. With their hybrid diesel and solar power capability they nominally will operation under solar power and utilize the generators as backup. The size of the containers make only a minor disruption of the local environment as can be seen in FIGURE 6 where the containers are nestled among the local foliage.

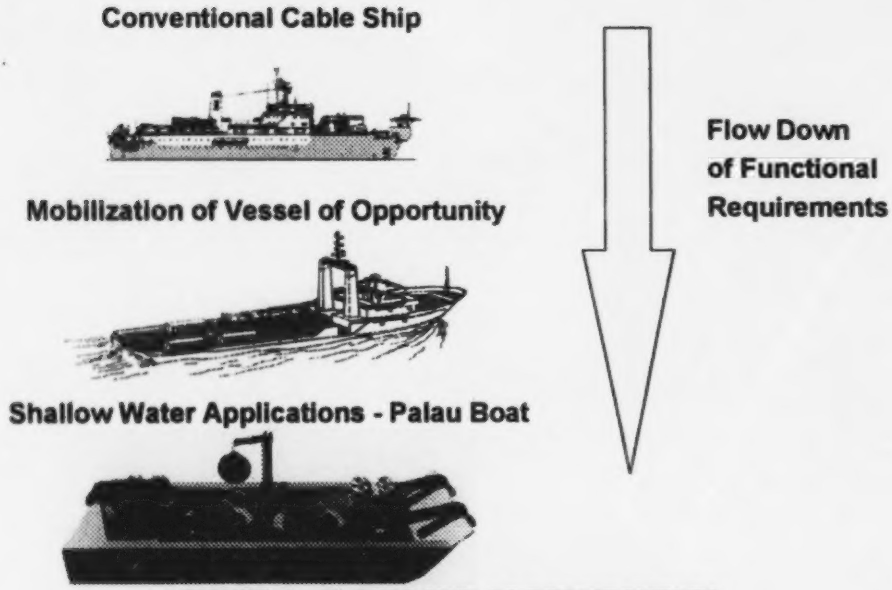
Conventional Cable Ship
Mobilization of Vessel of Opportunity
Shallow Water Applications - Palau Boat
Flow Down
of Functional
Requirements

FIGURE 4 - FLOW-DOWN OF REQUIREMENTS

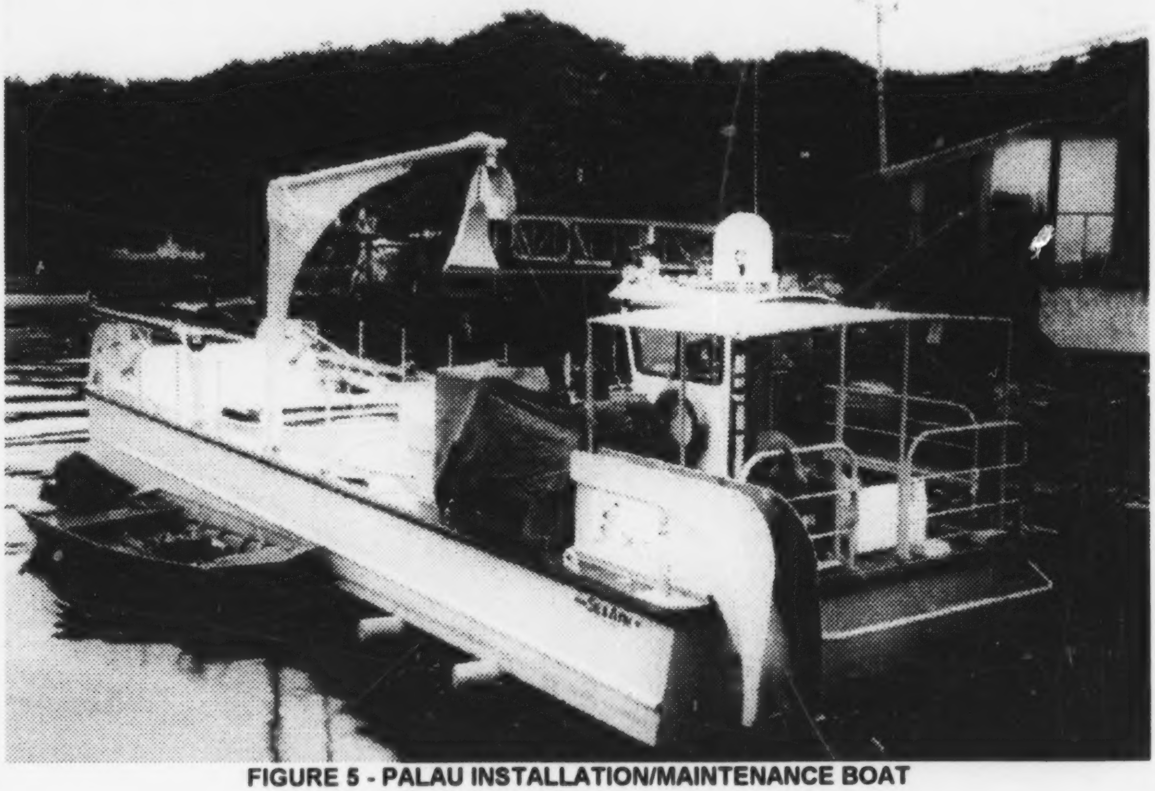

FIGURE 5 - PALAU INSTALLATION/MAINTENANCE BOAT

FIGURE 6 - CONTAINERIZED CABLE STATION

5.0 LESSONS LEARNED

5.1 ROUTE SURVEY

Short, shallow water installations require a balance between performing a detailed survey and having flexibility built into the system to allow for "real-time engineering". The amount of route survey performed for this project could have been augmented to better characterize bottom conditions and water depth along the proposed route. In one case, the survey had not shown the existence of a small island on the proposed cable route. At a minimum, the route survey for a Palau-like system should include an accurate picture of the bottom conditions, water depth and tidal conditions. Moreover, the entire route should be traversed by the installation boat prior to the lay.

The cable lengths and types were engineered using the information gathered from the route survey. With the expected route survey accuracy and the shallow water nature of the deployment, the segments were typically engineered with 0.5% slack and had factory prepared ends. While a more thorough route survey could have made for more efficient deployment, "real-time route engineering" will always be required. Thus as was the case with the Palau project, a certain amount of robustness in the solution must exist to accommodate the uncertainties and deviations from the planned cable route. A factory prepared termination on one end only is prudent with the other end cut to fit in the field where a field termination will be required.

5.2 CABLE DELIVERY SYSTEM

The installation/maintenance boat was capable of transporting a full 10 ton load of cable with a draft of less than 3 feet. (2 feet with the outdrives tilted up).
Maximum speed was about 10 knots fully loaded and 18 knots empty. During the installation the operation required a recover, splice and overboarding a segment of cable with the boat. The splicing area was a bit short on space and a little wet during the rain squalls, but numerous successful splices were performed.

While the boat was most certainly a success, some suggested areas for improvement are:

- to increase the beam and provide additional work space
- provide more weather protection to improve operations even during adverse weather conditions
- substituting outboards for the diesel/outdrive units

5.3 SUBMARINE CABLE

The Palau non-repeatered submarine cable having both a Special Application (SPA) and Single Armor (SA) design proved to be a high quality cable, robust and easy to deploy with the 46' boat. The SA was extremely easy to hand load and deploy. The SPA was easy to deploy, but somewhat difficult to load into the small tanks of the Palau boat. Using hardboard dunnage helped during loading to achieve uniform pan stowage, but reduced the amount of cable that could be carried and decreased the average load speed to about 1.5 km/hr. Since cable segments were short, typically 8 to 10 km, this reduced capability was a minor factor.

The cable uncoiled nicely and rested on the bottom in a very relaxed state with little undulations off the bottom due to cable set. All-in-all, the cable performed extremely well for this application.

5.4 TRAINING

PNCC was provided with the necessary tools, jointer equipment, splice training, and cable handling training to maintain the system in the future. However, as is the case with all cable splicing operations, regular or frequent refresher training is necessary. All submarine cable maintenance companies, having highly experienced cable crews perform quarterly training exercises for skills to remain current.

6.0 SUMMARY

The design and installation of the Palau inter-island Cable System represented several challenges in undersea network deployment. This system was drastically different from traditional systems because it was orders of magnitude smaller than most projects, while at the same time including more shore landings, a large amount of terrestrial work and very challenging logistics. These difficulties forced the supplier to "think out of the box" and develop innovative solutions. Most notable of the achievements were the development of the multi-purpose cable deployment and maintenance system, the implementation of the containerized cable stations and the adaptive on-site engineering that achieved the safe and on-time cable installation. The key to this success was the system approach to the design and installation of the Palau network that recognized the interdependence of the individual system components. Although there were numerous installation challenges, PNCC was provided with a state-of-the-art fiber optic telecommunications system on time and within budget. PNCC has now moved one step closer to achieving their ***Lightnet 2000*** vision.

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Biographies

John Mariano is responsible for developing new applications for undersea fiber optic networks for AT&T Submarine Systems, Inc. (AT&T SSI). His extensive experience in telecommunications technology includes more than 25 years as a development manager at AT&T Bell Laboratories. He now heads a sales organization chartered to develop non-traditional and new users of this technology. Mr. Mariano holds a Master's Degree in Applied Mechanic from Stanford University and a Civil Engineering Degree from the University of Connecticut.

Dave Rishar- is the Senior Marine Engineer in AT&T Submarine Systems Cable Ships & Submersibles District and is responsible for the maintenance of AT&T's fleet of 7 cable ships. A 20 year Coast Guard veteran, he has extensive experience in the operation and maintenance of ships. Mr. Rishar has been responsible for the acquisition and conversion of the Coastal Connector and the design and acquisition of the Palau cable boat. He holds a Bachelor of Science degree from the State University of New York and has a USCG Chief Engineer's License.

Developing Standardized Procedures for the Planning of Secure Subsea Telecommunication Cable Systems in Underdeveloped Regions

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1. ABSTRACT

Experience has shown that for submarine telecommunications cable systems to meet their expected design life and life cycle maintenance budgets, system planning, survey and installation procedures play a vital role.

This paper provides a set of standardized procedures that have been developed to guide the telecommunications engineer involved in the planning of submarine cable systems in underdeveloped regions, through the critical phases of initial conceptual design, feasibility study, desk top studies and route survey, to installation and maintenance.

Each procedure is briefly described with examples of the impact of each procedure on system survivability potential. Emphasis is placed on procedures that examine the political and cultural constraints that can impact on subsea cable route planning and security in developing regions of the world, in addition to the constraints that can be imposed by the physical environment along the route. The paper continues with a discussion on route survey specifications and the application of optimum route survey technology. In conclusion, the paper emphasises the critical role of the route survey in providing adequate and accurate information necessary for the definition of the most appropriate installation solutions for the system.

2. INTRODUCTION

As a means of upgrading their telecommunications infrastructure to enable connectivity with the Global Information Infrastructure, underdeveloped regions are being encouraged to invest in subsea telecommunications cable systems. The arguments presented in favour of investing in submarine cable systems are the apparent low entry level costs, short implementation lead times and the high capacities and bit rates made possible by fibre optic cables and digital terminal equipment technology.

Evidence that these arguments have been accepted by developing countries can be seen in the surge of investment in domestic and intra-regional submarine telecommunications since 1990. In particular, during this period, there has been a proliferation of unrepeatered single span, inter-island and coastal festoon systems that have been brought into service or are currently being installed or planned in underdeveloped regions. The importance of uninterrupted service and restricted restoration possibilities in underdeveloped regions together with the high revenue potential of today's high capacity fibre optic submarine cables is evident. Experience being gained into submarine cable damage risk factors, has emphasised the crucial importance of proper system planning, route selection, the definition of installation parameters and appropriate maintenance capability if submarine telecommunication cable systems are to meet their expected design life and life cycle maintenance budgets.

It is apparent that the degree to which the objectives of each project phase of submarine cable system planning and implementation can be successfully achieved will be considerably influenced by the procedures being followed by system owners and the various parties that are contracted during the project. All too often in the past, out of date or inappropriate generic specifications have been issued to survey contractors. While there is evidence that the situation is improving due to system suppliers having to accept greater liabilities in their supply contracts, it is still common for the procedures and scopes of work being specified to remain inconsistent with the objectives that are to be met and the liabilities that are to be accepted. In many cases the procedures being followed and the specifications being issued and which must be complied with, reflect the inexperience and lack of specialist knowledge of the procuring parties in some of the more esoteric aspects of submarine cable system planning and construction. While this situation still persists within even the larger traditional telecommunication carriers and system suppliers, it is with the system owners of emerging nations and the new generation of non traditional telecommunications carriers where the lack of appropriate procedures is most evidenced.

The purpose of this paper is to propose a set of standardized procedures that have been developed by the author to guide the telecommunications engineering team charged with the responsibility of planning submarine cable systems in underdeveloped regions through the critical phases of initial conceptual design, feasibility study, desk top studies and route survey, through to installation and maintenance considerations.

The procedures proposed follow the Integrated Approach set out by Evans [4]. Conceptually, the integrated approach brings together the interdisciplinary skills of telecommunications engineers, surveyors, geoscientists, cable engineers and installers during each critical phase of the planning, survey and final design of submarine cable systems (see Figure 1).

INTEGRATED MULTI-DISCIPLINE PROCEDURES FOR SUBSEA CABLE ROUTE PLANNING

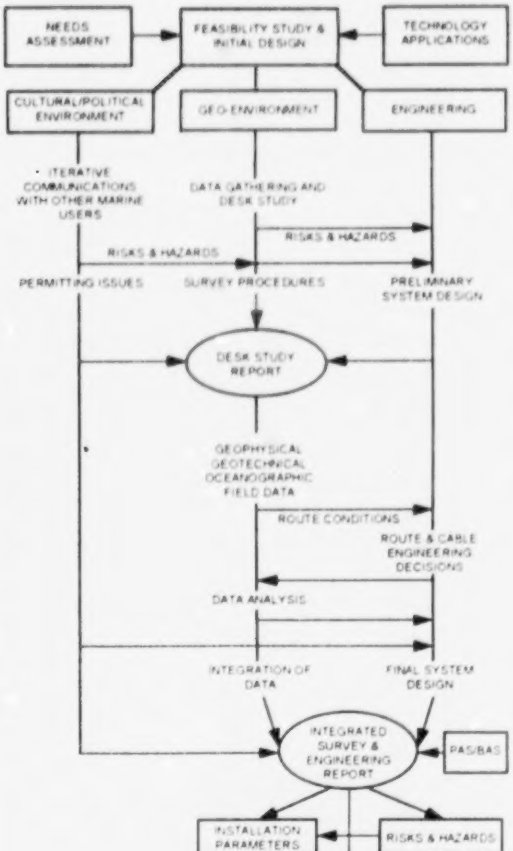
NEEDS ASSESSMENT
FEASIBILITY STUDY & INITIAL DESIGN
TECHNOLOGY APPLICATIONS
CULTURAL/POLITICAL ENVIRONMENT
GEO-ENVIRONMENT
ENGINEERING
• ITERATIVE COMMUNICATIONS WITH OTHER MARINE USERS
DATA GATHERING AND DESK STUDY
RISKS & HAZARDS
RISKS & HAZARDS
PERMITTING ISSUES
SURVEY PROCEDURES
PRELIMINARY SYSTEM DESIGN
DESK STUDY REPORT
GEOPHYSICAL GEOTECHNICAL OCEANOGRAPHIC FIELD DATA
ROUTE CONDITIONS
ROUTE & CABLE ENGINEERING DECISIONS
DATA ANALYSIS
INTEGRATION OF DATA
FINAL SYSTEM DESIGN
INTEGRATED SURVEY & ENGINEERING REPORT
PAS/BAS
INSTALLATION PARAMETERS
RISKS & HAZARDS
SYSTEM MAINTENANCE BUDGETS & STRATEGY

Figure 1.

The essential ingredient to the integrated approach is that input from each discipline are put together and considered collectively to fully define the system and cable route in terms of physical conditions, cultural and political constraints to route development, route length, system engineering including final cable quantities and types, and system installation parameters and planning. Whilst the integrated approach is conceptually simple, the details of project execution can be complex with the degree of complexity varying from project to project depending on the system being planned. Figure 1 shows diagrammatically the complex interrelationships between the various skills and disciplines employed during an integrated system planning programme.

The scope of this paper is confined to the procedures and activities involved in the physical design of the submarine cable system from beach manhole to beach manhole. The author does not purport that the procedures proposed in this paper should be considered to be fixed and exhaustive, but rather as a guide to essential aspects of submarine system planning based on experience of planning submarine systems in both developed and underdeveloped regions of the world.

3. FEASIBILITY STUDY & CONCEPTUAL DESIGN

It is beyond the scope of this paper to consider issues concerned with network architecture and transmission protocols. However, the feasibility study and initial conceptual system design phases of the planning of a submarine cable system require procedures to be in place that enable the service provider to assess the needs for the telecommunications system envisaged, to determine the most appropriate technology applications, and to determine the initial network design, cable quantities and engineering parameters.

3.1 NEEDS & TECHNOLOGY ASSESSMENT

The needs assessment procedures should focus on assessing current communications requirements and evaluating the service providers objectives and growth plans. This sub phase would include evaluation and planning of voice, data and video requirements; an analysis of current and projected future traffic patterns and message volumes over the intended design life of the system. Based on the results of the needs assessment, the initial system configuration will be determined by the location of centres to be serviced and existing network infrastructure and nodes.

Procedures applied to the definition of initial system design should concentrate on the application of technology that will effectively balance performance against costs over the life cycle of the system. It is important for the design team to be cognisant of current and emerging technologies to develop network design alternatives and to define parameters for critical system elements such as capacity, transmission speed, integration network control, accuracy, redundancy and reliability. In cases where terrestrial and submarine options are available, an assessment of the comparative technical and economic viability of each will be made at this phase of system planning.

3.2 PRELIMINARY PLANNING PROCEDURES FOR SUBMARINE CABLE SYSTEMS

In the case of submarine cable system planning, it is particularly important that during the feasibility study and initial conceptual design phases, procedures are in place to enable the design team to assess and evaluate the risks and hazards to which the cable system may be exposed. In this way system planners are able to estimate the costs of damage prevention engineering, special installation requirements, and the life cycle maintenance budget for the system. These considerations are even more critical where systems are to be installed in underdeveloped regions where traffic restoration possibilities are restricted and where system owners may have restricted access to maintenance facilities.

Such procedures should include:

- Preliminary examination of available charts and literature pertaining to the landing sites and preliminary cable routes between the landing sites.
- Determination of political constraints to cable routing for example international boundaries and disputed territorial claims.
- Determination of physical constraints to cable routing and installation, for example rock and coral outcrops, seismic activity, excessive sea bed slopes, sand waves etc.
- Determination of cultural constraints to cable routing and associated risks, for example fishing activities, offshore mining and hydrocarbon exploration and production, coastal developments, offshore dumping grounds, marine parks etc.
- Determination of way leaves and rights of way at the landing sites and the availability of land for terminal station construction.
- Identification of viable cable landing site locations.

3.3 LANDING SITE SELECTION

All to frequently, the positions of the landing sites are changed after the survey has been completed. Often the reason for changes in the landing site position is the failure to unambiguously conclude way leaves and rights of way issues and/or terminal station land acquisition prior to performing the route survey. It can be seen therefore that procedures must be in place to enable the owner and system planner to have completed landing site selection on the basis of system structure, during the feasibility study and initial conceptual design phase of the system planning process, and to firmly establish the necessary rights of way and way leaves for the route approaches, manhole position and terminal station site prior to commencing the route survey.

However, before the issues of way leaves, rights of way and terminal station land acquisition are addressed, the system planning team should ensure that the landing site location is technically viable and that it will fulfil the design life criteria for the planned system. The assessment of technical viability must take account of the factors discussed in the following Desk Study section, in particular:

- Cable protection and burial requirements.
- Constraints imposed by cultural activities.
- Constraints imposed by the physical environment.

4. DESK STUDY

The importance of the desk study cannot be overstated when planning submarine cable systems. Desk study procedures are therefore extremely critical to the cable route planning process and errors and omissions during this phase can have extremely costly and far reaching consequences during the later phases of the project, for example during the route survey where extensive route development or route diversions may result from inadequate or inaccurate information being provided in the desk study; during the installation, or worse, during the service life of the system.

Whilst the desk study is typically the responsibility of the appointed survey contractor, the procedures under the Integrated Planning Approach require inputs from an interdisciplinary team of experts from the fields of telecommunication system planning, surveying, geosciences, cable engineering and cable installation [5]. The desk study should form a logical more in-depth continuation of the processes performed during the feasibility and initial conceptual system design phases of the project. The desk study procedures should address the following principal objectives:

- Confirm system feasibility and enable system budgets to be refined.
- Enable preliminary system design and configuration parameters to be confirmed and refined.
- Identify and fully define cultural activities and physical conditions along the preliminary cable route that may impact system design.
- Identify and fully define political and environmental constraints that may impact system design.

- Enable the route survey scope and procedures to be correctly defined.

During the desk study, existing literature and information both in the public domain or, where available, other less accessible data bases would be reviewed. In underdeveloped regions such information may be scarce, or information may be held in the data bases of international institutions involved with aid related studies in the region.

Submarine cable system security and survivability potential is not solely related to the physical conditions along the cable route, cultural activities have been shown to be a far greater cause of cable system outages [6]. It is therefore a primary function of the desk study procedures to identify and notify all other potentially conflicting seabed users of the intention to install a cable across the seabed where they may have an interest, and where necessary, to negotiate a mutually acceptable route prior to the field survey. Typically the most common routing conflicts occur with offshore hydrocarbon developments or with sea bed mining operations. In underdeveloped regions, such operations may be absent, in the early stages of development, or be playing an important role in the economic development of the region. Other likely routing conflicts may occur due to coastal fishing activities, marine conservation areas and coastal tourism developments. As submarine cables typically land at and/or link main coastal population centres, it will be important for the desk study to identify routing conflicts due to existing or planned future coastal developments for example ports and harbours, coastal power stations and chemical plants.

Desk study procedures should ensure that a clear understanding is gained of political issues that impact on cable route planning, installation and long term maintenance of the system. Such issues include permitting, international boundary crossings and territorial claims of both landing and non-landing parties. There have been a number of precedents set involving the need for post survey re-routing, substantial and costly delays to installation programmes and claims for substantial compensation from non landing parties with conflicting territorial or EEZ claims.

Desk study procedures should emphasise the importance of deriving maximum data gathering benefit from the landing site visits which should form an important integral part of the desk study task. The site visits should be used to gather information from local government offices and other relevant authorities administering the regions in which the landing sites are located. The following factors have proven to be critical in refining submarine system design in emerging nations and underdeveloped regions in Asia Pacific:

Coastal Construction

Planned coastal construction schemes in the immediate vicinity of landing sites. Such schemes are likely to impact on cable security along the cable route approaches to landing point, for example, port developments that may require the dredging of channels across the proposed cable route or the gazzeting of new anchorages, plans for new coastal resorts, planned construction of outfalls and intake structures.

Fishing Activity

Fishing activity and the type of fishing equipment used has had a significant impact on submarine cable planning and protection strategies, for example the serious damage caused to submarine cables in Korea due to stow net fishing has now dictated that cable burial to 2.5 to 3.0m be a standard requirement where this type of fishing activity is performed. In Asia, aquaculture and fish farming is a major industry. There have been many examples where cable laying operations have been seriously delayed due to the intervention of the fishery authorities or local fishing communities who have either not been or improperly advised of the installation of a submarine cable across their fisheries. Often such cases have resulted in the need to relocate landing sites and/or the need to pay large compensation claims.

Offshore Oil & Gas Operations

Offshore hydrocarbon developments that may require the construction of in-field transmission pipelines or the construction of new pipelines to the shore following cable installation. Existing pipelines need to be identified where these will be crossed by a new cable system.

Military Activity & Ordnance

The history of any wartime activity or past and present military exercise areas in the area which may indicate the presence of live ordnance within the seabed sediments or on the beach.

Existing Cables

Existing or planned telecommunications and power cables that may need to be crossed.

Due to the importance of protecting the cable as it transits through the shallow water and across the beach to the beach manhole, emphasis should be placed on investigating the physical conditions at the landing sites including:

- Coastal and nearshore geology

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- Beach and seabed stability, including determining the nature and composition of beach and nearshore soils, the noting of indicators of shoreline instability including the presence of offshore bars, washouts, beach erosion and slumping.

- Meteorological and oceanographic environment, including seasonal variations and season and frequency of extreme events, for example typhoons.

The desk study procedures will result in a detailed Desk Study Report and System Planning Charts. The report contents should include:

- All the information gathered during the desk study.

- The provisional cable route in the form of both a physical description and route position list that has been developed during the initial conceptual system design and desk study phases of system planning. The provisional route would also be plotted on the system planning charts showing all route alter course points.

- Definition of provisional cable quantities, and cable engineering including provisional cable armouring schemes.

- Full detailed descriptions of the system landing sites.

- Full details of route permitting issues and procedures including the status of routing negotiations.

- Definition of detailed route survey procedures and scope of work which should be based on the most appropriate technical approach that addresses the prevailing physical conditions of the route, and the cable protection and installation strategies recommended in the report.

5. ROUTE SURVEY

Two sub-sets of procedures are required during the route survey phase of submarine cable system planning. The survey procuring party must have a set of appropriate procedures in place to correctly define the objectives, scope of work and specifications to be presented to the survey contractor, whereas the survey contractor must have a set of operational and QA/QC procedures that will ensure that the objectives, scope of work and specifications are complied with to the required professional standards.

5.1 PRIMARY OBJECTIVES

The route survey procedures should be focused on achieving the survey's primary objectives as follows:

- Provide all the necessary information required to confirm or amend the preliminary cable route developed during the initial conceptual system design and desk study phases of the system planning process.

- Define and fully document a final, safe, technically and economically viable route.

- Enable final cable engineering and protection parameters to be defined and final cable quantities to be calculated.

- Provide the system installer with all the data required to finalise installation procedures.

- Enable potential residual post installation hazards to be identified that could impact on the system's long term survivability and maintenance life cycle costs.

5.2 ROUTE SURVEY PROCEDURES - GENERAL CONSIDERATIONS

With the high capacities and transmission rates of advanced fibre optic submarine telecommunications cable systems, and the statistical fact that more than 70% of submarine cable outages are due to damage inflicted by third parties on the continental shelf, it is not surprising that system owners strongly focused on cable protection to protect their investments and revenue earning potential. Effective cable protection to insure against service interruptions is of particular importance in underdeveloped regions or in developing countries due to restricted traffic restoration possibilities and lack of access to maintenance facilities.

Cable burial is generally the preferred method of cable protection across the continental shelf sections of submarine cable systems. Over recent years the trend has been for cables to be buried ever deeper beneath the sea bed and to ever greater water depths in response to improving fishing technology. Examples of these trends can be seen with the first Thailand festoon system installed in 1992/93 with a burial depth of 0.6m, and the second festoon operated by the same owner requiring burial to 1.5m. An example of cable burial being extended to greater water depths can be seen in the PACRIM cables which have been buried to a water depth of 2,000m compared to a previously accepted norm of ± 200m.

Effective operational planning of the installation and to circumvent some of the potential installation problems associated with cable burial, the installer requires detailed knowledge of the soils profile to the full depth of burial along the cable route. It is therefore apparent that procedures must be in place to ensure that the route survey scope of work and specifications are fixed so that the essential requirement of the route survey to provide the cable installer with all the information needed to define the most appropriate installation technology and risks will be achieved. To achieve this objective, the route survey practices should provide throughout the data acquisition phase of the route survey for the real time integration of the interdisciplinary expertise that is needed to develop a full understanding of the often complex along-route geosystem, and to facilitate the making of objective routing refinements that may be necessary to meet the objectives of system burial, optimum system engineering and installation.

5.3 ROUTE SURVEY PROCEDURES - SPECIAL CONSIDERATIONS FOR UNREPEATERED SYSTEMS

Whilst unrepeatered submarine cable systems are not the exclusive domain of underdeveloped regions, the apparent competitive entry level costs of these systems has increasingly seen unrepeatered systems being accepted as the preferred solution to the need for telecommunications infrastructure upgrading in developing parts of the world [2]. A characteristic of unrepeatered systems, specifically coastal festoons and inter-island systems, is the high ratio of landing sites to system length, for example the PLDT Philippines Domestic Inter-island system with 23 landings and a route length of 2,300km. It is evident therefore, that with the shore end surveys forming a particularly critical component of the overall route survey effort, appropriate procedures and survey scope of work must be correctly defined that in addition to addressing the issues discussed above, must address the particular difficulties at system shore end approaches and landing sites.

The shore end approach, typically defined as that section of a cable route lying in water depths shallower than ± 10m, presents the route surveyor with a particular set of technical problems that need to be properly addressed in the survey procedures, scope of work and specifications, if the survey is to provide the quantity and quality of information needed by the installer [3]. These problems are due to the shallow water depths along the route approaches, the operational limits both the survey vessel and the survey tools that are traditionally employed; and the fact that at the shore ends, the geo-environmental conditions are changing most rapidly. This last point is particularly critical to the installation contractor as burial performance is most affected by lateral variations in soils and geological conditions, and it is in the very shallow water where conventional geophysical survey methods fail to provide reliable data. The difficulties in the shore end surveys are further compounded by the need to provide the installer with geotechnical data to the full burial depth required, which increasingly is deeper than for the main offshore route. An example of the deeper burial requirements at the shore end can be found at the Singapore Changi approach for the APCN cable, where burial was required to a depth of 10m in soils and 4m in rock.

As discussed above, the landing site position based on technical viability and the necessary rights of way and way leaves for the route approaches, manhole position and terminal station site should be firmly established prior to the commencement of the route survey. As in certain circumstances this may not be practical, the survey scope of work should provide for the necessity to survey a wider corridor in the nearshore region in order to maintain flexibility, or alternatively, more than one landing option should be surveyed. This is to avoid the need for costly re-surveys in the event that landing site positions are changed, or in the case where landing sites are changed without a re-survey, to avoid expensive claims from the installation contractor in the event that unsurveyed ground conditions prevent proper cable protection.

5.4 ROUTE SURVEY SPECIFICATIONS & SCOPE OF WORK

Whilst outside the scope of this paper to discuss survey equipment and the various survey techniques and limitations in detail, it will be apparent from the foregoing that the degree to which the route survey can successfully achieve it's primary objectives, can be considerably influenced by the survey specifications and scope of work included with the survey request for quotation. An additional factor influencing the outcome of the survey is the time of year the fieldwork is performed which should coincide with the most favourable weather season.

In the past it has not been uncommon for generic specifications to be issued to survey contractors which do not correctly address the survey objectives but with the requirement that the contractor must comply. In many of these cases, the specifications issued reflect the inexperience and lack of specialist survey knowledge of the procuring party, thus making the tender adjudication process less effective. The problem of tender adjudication is often exacerbated when proposals submitted by contractors include options that are intended to compensate for specification inadequacies. It is clear therefore, that the procuring party must have procedures in place that allow for the generation of the most appropriate survey specifications and scope of work for a given project.

Field investigation procedures and scope of work should be properly defined on the basis of information gathered during the desk study. The scope of work should fully address the predicted conditions along the route and the requirements of the installer to be provided with all the information needed to achieve the installation requirements. The most fundamental data components of a cable route investigation are:

Bathymetry

The collection of bathymetric data is fundamental in any marine survey operation. In the case of cable route surveys (or indeed any seafloor mapping task), the question is whether to employ conventional single beam echo sounding or swathe bathymetry techniques. Swathe bathymetry is being increasingly accepted as the industry standard as this provides considerably more data and hence a more accurate representation of the seabed topography within the survey corridor. Swathe methods also enable routing decisions to be made semi real-time when adverse bathymetric terrain is encountered.

Sea Bed Imagery

Side scan sonar and in some cases multibeam echo sounder imagery, gives a plan view of the seabed surface along a corridor centred on the track of the survey vessel. This data not only provides valuable information on seabed topography that may be correlated with the bathymetric data, it also yields information on the characteristics of the seabed surface sediments. In this way outcropping rock and coral, and non geological objects showing positive relief above the seabed occurring off the track of the survey vessel may be identified and mapped.

High Resolution Seismic Reflection Profiling

Seismic reflection profiling is used to provide a continuous along track record of the sub seabed soils profile and underlying geology. Seismic reflection profiling allow significant geological features such as landslides and faults and rock outcrops to be immediately identified and mapped, thus where cable burial is required route deviations can be implemented to avoid terrain where burial may be difficult or impossible.

Sea Bed Soils Data

Sea bed soils data is required for "ground truthing" the seismic data collected during cable route surveys. Obtaining this data has traditionally relied on gravity coring, or more rarely vibrocoring. With the increased demands being placed on the cable installer to bury cables deeper and over longer sections of the route, greater emphasis has been placed on more innovative ground truthing methods that will provide reliable data to the maximum required burial depth. Such methods involve remotely operated lightweight cone penetrometers (CPTs) and electronic burial assessment devices. It is important that during the cable route survey adequate ground truthing data is collected that adequately represents the variations in soil conditions identified along the route and that on-board testing procedures enable provisional burial and plough assessment to be made so that rapid re-routing decisions can be made while the survey vessel is in the problem area.

Submarine Geology

In the case of cable route surveys it is unusual to carry out a programme of borings deeper than the typical 3m cores obtained by gravity coring, the ± 6m penetration of a CPT rig. The prevailing geological conditions along the cable route therefore, is most commonly derived from a literature search during the desk study phase of the investigation, from interpretation of the seismic data and from the drop cores collected during the survey. An understanding of the route geology is important where the route passes through seismically active areas, areas of active faults such as may occur at the continental shelf edge and continental slope, areas of submarine volcanic activity and in areas where active hydrocarbon gas venting occurs. Other geological information that may need to be understood within the context of cable system design include seabed temperatures and radioactivity.

Electronic Burial & Plough Assessment

Conventional burial assessment surveys (BAS) have traditionally been carried out after the completion of the electronic route survey. New electronic burial assessment (E-BAS) systems being developed will allow simultaneous burial assessment and route engineering concurrently with the route survey operations [1].

Oceanography

Oceanographic data, particularly data on seafloor currents, may be important in some environmental conditions, for example, in areas where seabed scouring could affect the long term security of the cable system, in areas of high current flow near beach landings where shore end installation could be adversely affected, in areas of sand waves where cable re-exposure may be a significant risk, or in areas where high current velocities combined with a rough seabed could result in excessive wear on a surface laid cable. In many cases, oceanographic information will be gathered during the desk study. This information may, in a benign environment, be considered to be adequate for the purposes of installation planning and system risk analysis. However, seismic, imagery and bathymetric data collected during the survey, may show submarine evidence indicating high current velocities along the cable route, in these cases there needs to be enough flexibility in the survey procedures to accommodate the need to acquire additional current data.

5.5 THE ROUTE SURVEY REPORT

The survey specifications should clearly define the parameters for reporting on the route survey. The report format should include the following basic components:

- A comprehensive narrative descriptive text providing descriptions of the survey activities and procedures.
- A detailed narrative description of the route, final route position list and a straight line diagram of the system.
- Highlight all areas identified during the survey where problems may be encountered during installation and which would benefit from additional PAS or BAS operations.
- A full set of System Charts in either hard copy and/or in electronic format depicting the route at the most appropriate scale.

The most often referred to part of a route survey report are the System Charts. Whilst there are a number of differing opinions on the preferred chart presentation format, the format in most common use in Asia Pacific comprises:

- Alignment Charts that usually include 4 panels of information, typically, vessel track, bathymetry, seabed features and geological cross section. The orientation of these charts is parallel to the route.
- Bathymetric Charts oriented north-up depicting bathymetric contours and marine features but without the route being shown. Following installation and the plotting of the as-laid position of the cable, these charts ultimately become the final system charts.
- Cable Charts oriented north-up which in addition to the information shown on the Bathymetric Charts also show the as surveyed route and core sample locations.

6. INSTALLATION & MAINTENANCE CONSIDERATIONS

The foregoing sections of this paper have been directed towards the procedures and systematic processes involved in the planning of new submarine telecommunications cable systems, that will provide reliable service to the owner over the design life of the system and within the budgeted life cycle costs. Whilst outside the scope of this paper to deal with installation and maintenance issues in detail, the following brief notes have relevance to the topics covered.

6.1 INSTALLATION ISSUES

As discussed above, the route survey plays a critical part in the provision of adequate and accurate information necessary for the definition of the most appropriate installation solutions that address the residual risks and hazards to the cable such that they will meet the owner's objective of maximising system survivability potential. From the information provided, the installer should be in a position to develop an installation strategy and set of operational procedures that will achieve the system protection criteria defined during the planning process.

In order to correctly identify the most appropriate installation plant for the system, the planning team will need to have an understanding of the range of potential installation solutions available that will not only meet the specified protection criteria but also the physical conditions prevailing along the route. For example, in underdeveloped regions where the use of lightweight cables are typically being used for repeaterless systems [2], it will be necessary for the owners to critically assess and validate the installer's proposed installation procedures, in particular:

- Procedures to ensure precise and agile vessel handling to prevent the vessel from overstressing the cable during installation.
- Procedures to provide for the use of specialised deck and rigging practices for the handling of the cable type being installed, for example, small linear cable engines and more sensitive overboarding procedures for final bights.
- Procedures to provide more sensitive subsea cable burial equipment to minimise the possibility of damaging the cable during burial.
- Proposed procedures that demonstrate that the burial tools will achieve the specified burial depth in all the sea bed substrate conditions identified by the survey.
- Procedures that provide for installation and burial across long inter-tidal flats.

For larger repeatered systems that comprise both shallow and deep water route sections, procedures employing split shore end and deep water installation solutions may be the most appropriate.

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6.2 MAINTENANCE CONSIDERATIONS

Due to the high revenue earning potential of fibre optic submarine telecommunications systems, and the limited traffic restoration possibilities in underdeveloped regions, how submarine telecommunications cable systems are to be maintained, should form an essential part of the project economic viability study procedures. Typically, systems in underdeveloped regions will not have access to a regional submarine cable maintenance agreement. Therefore, unless the region has other submarine telecommunications operators willing to share facilities for shared investment in maintenance, it is unlikely that a suitably equipped call-out maintenance facility will be an option. In these cases, owners will have to balance the cost of ever more conservative protective system engineering and traffic revenue losses during the repair response time, with the cost of constructing a system specific speciality maintenance facility. Precedents for this solution can be found in Thailand with the *Jasmine Protector,* a self propelled shallow water barge assembled and employed exclusively for the maintenance of the Gulf of Thailand Domestic-1 Festoon System. A similar arrangement can be found in Malaysia for maintaining the Time Telekom Coastal Festoon System and more recently in Palau.

7. CONCLUSIONS

Submarine telecommunications systems are providing the means of upgrading the telecommunications infrastructure and connectivity with the Global Information Infrastructure in underdeveloped regions.

Experience being gained into submarine cable risk factors and the increased liabilities being passed on to system suppliers has emphasised the need for coherent system planning processes from initial conceptual design to installation and maintenance.

An integrated multidiscipline approach to the planning of subsea telecommunications cable systems in underdeveloped regions is proposed as a set of standardized procedures which provide a number of significant benefits including:

- Providing a single coherent planning effort incorporating all the necessary interdisciplinary inputs from telecommunications system planners, geoscientists, cable engineers, surveyors and installers.
- Optimises the value of the varied inputs to the planning process and facilitates the evaluation of each type of data and procedure in relation to each other type of data and procedure, thus greatly increasing the understanding of route conditions from the perspective physical, cultural and political impacts on route design.
- By adequately defining route conditions at an early stage of system planning, the integrated approach helps to eliminate delays in system implementation that could result from unforeseen physical, cultural and political constraints.
- The proposed integrated approach provides the potential for the most cost effective engineering design of the system by adequately understanding all the interrelated conditions of the route.

The paper discusses the importance of applying the correct route survey specifications and the basic survey technology components are briefly described and referenced to their relevance in providing the information necessary to the installer for the development of installation procedures.

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The Impact Of Private Investment Ventures On The Submarine Cable Industry

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Abstract

This paper will examine the significant changes in the way submarine cable systems are planned, financed and owned due to the growing number of private investment ventures. It will also examine the major trends leading to the proliferation of these ventures in recent years, including the increase in the number of regional and domestic systems worldwide, the growth of entrepreneur based cable system ownership, the entrance of non-traditional suppliers to the industry, and the increase in capacity needs as created by the explosion of new multimedia services associated with broadband applications. This paper also will also analyze the primary forces driving fundamental changes in cable system ownership. Finally, this paper assesses the impact of increased trade on the communication needs of multinational corporations for seamless connectivity and ubiquitous services.

The Impact of Private Investment Ventures on the Submarine Cable Industry

1.0 Introduction: Growth In A Historically Changing Industry

One of the abiding traditions of the submarine cable industry over the years has been an inability to predict cable utilization accurately. Despite the application of advanced analytical tools and accurate data, changes in the market environment and technology have generated demand that outstrips the industry's capacity to deliver.

Others might envy the growth record of the submarine cable industry, however, the industry itself would prefer to look toward greater stability. From the vantage point of late 1996, that outcome still seems far away. The latest influence to force continuing change in the industry is the growing number of private investment ventures.

Trying to understand the role of private investment ventures involves complex factors that have been churning the waters for the past decade. It is not a matter of private investors suddenly entering the market as an external force. Rather, the recent and rapid growth of private investment reflects a dynamic that includes the changing composition of owners, carriers, traffic, and end users within the global telecommunications network. The sheer number of new submarine systems going into service exerts a major global impact: traditional development resources cannot keep up with demand. Factored into that dynamic is an explosion of multimedia services associated with broadband applications and the capacity demand those applications create.

Finally, the changing nature of global trade and the rise of multinational corporations (MNC) as consumers of communications services has had a tremendous impact on both investment and ownership trends. A considerable amount of private investment pressure comes directly from these business consumers driven by their seemingly insatiable demand for seamless connectivity and ubiquitous services. Thus, the picture becomes further complicated by the emerging role of end users as owners.

2.0 Change Drivers 1996

The primary change drivers affecting the development of submarine cable systems are the following:

- Worldwide movement towards privatization and liberalization in the regulatory environment
- Increasing influence of regional trading alliances and the concomitant need for inter- and intra-regional communications (i.e. NAFTA, GATT, APEC)
- Rapid technological advances

There has been a great deal of discussion of the anticipated impacts of these influences as they have developed over the past several years. In 1996, what is different about these influences is that most of these factors came into maturity almost simultaneously. Their combined impact was much larger than the sum of the impact each might have made and significantly greater than anticipated.

2a. Privatization and Liberalization of Telecommunications

The movement towards privatization and liberalization in the regulatory environment is fairly complete, especially in North America and Europe. Even those nations whose traditional grip on state-owned and operated PTTs seemed iron-tight a few years ago saw the introduction of new carriers and competitors into their lucrative inter-exchange marketplace. One of the direct advantages of privatization, of course, has been the infusion of new capital into telecommunications infrastructures around the world. Obviously, this trend splashes over into submarine cable systems. Thus, the privatization of national telecommunications systems is in direct parallel with increasing private investment in submarine cable systems of all sizes.

In parallel with privatization and liberalization in those regions where national PTTs once owned monopolistic telecommunications systems, the forces of deregulation and legislative reform in the United States have all but eliminated the vestiges of the monopoly/duopoly models of the past decade. The passage of the *Telecommunications Act of 1996* paves the way for new competition in voice, data, and television services at all levels.

In addition to competition for network services and programming, these changes also introduced competition among the various modes and combinations of services. The range of competing wireline and wireless telephony services included competition between analog and digital services and among cellular, personal communications, paging, and messaging services. On the television side, competition had begun to arise among traditional cable, hybrid fiber-coax systems, and direct digital satellite systems. The *Telecommunications Act* now throws everything into the same mix, enabling local exchange carriers, inter-exchange carriers, wireless services, and cable television providers to compete for as narrow or as wide a share of the overall communications market as they chose or dare.

This U.S. model shows how competition helps to expand the marketplace rather than reduce it. Moreover, market expansion will not be contained within national borders. The competing services distributed so broadly across the United States are moving rapidly into Europe, Asia, and South America.

One cannot speak of expanding local telecommunications marketplaces without also understanding that parallel expansion occurs within international markets. Information and ideas do not respect international boundaries. As rapidly as ideas cross frontiers, so, too, will the information infrastructures to carry those ideas. Competing ideas, competing modes of information technology, competing services are more than outcomes of privatization and liberalization. They both feed on and drive privatization in the same way that a breeder reactor generates energy and the fuel needed to generate additional energy in the same process. The differences between the privatization model and the breeder reactor is that the privatization model works.

2b. Regional Trade Alliances

Intimately entwined in the trend toward global privatization and liberalization of telecommunications networks and services is the rapid rise of regional trading alliances and their concomitant need for inter- and intra-regional communications. As the original regional trading alliance, the European Community is clearly the world's leader in this arena. Although the United Kingdom is arguably the world leader in competitive telecommunications opportunities, European Community initiatives have pushed other member nations to open their markets, too, all to the benefit of all the players.

In addition to the European Community, one can find regional alliances on every continent and within every regional trading area. Even before the North American Free Trade Agreement (NAFTA) became a reality, Mexico was very actively engaged in privatization and in attracting investment from abroad. With the adoption of NAFTA, Mexico's aggressive push towards privatization accelerated its ability to participate as a partner, offering multinational and transnational enterprise telecommunications capabilities competitive with Canada and the U.S.

This type of regional cooperation is taking place throughout Latin America, across Asia and the Pacific, in North Africa and the Middle East, among the nations of the former Soviet Union, and to some extent in sub-Saharan Africa. Regional trade not only requires a common communication infrastructure among the trading partners, but the evolution of these regional infrastructures also supports the growth of regional trade. Again, another pair of elements that feed off of each other.

2c. Technological Advances

Advances in optically amplified repeaters and wavelength division multiplexing have expanded the capacity of *today's commercially available* systems to 20 Gb/s. per fiber pair with research taking us to higher and higher rates. Developments in terminal equipment have allowed for the deployment of globe spanning self healing rings. New branching unit designs have enabled a single cable system to serve a significant number of countries.

All this adds up to lower bandwidth costs as well as simpler, more reliable systems. Simpler systems are easier to install and cost less per kilometer. More reliable systems are less expansive to maintain. These advances enhance the attractiveness of submarine fiber optic cable systems to investors, because they promise higher revenues at lower costs for overall higher profitability.

3.0 Private Investment Ventures

In a simpler time, when undersea cable development was the unique domain of a handful of global carriers, financing was linked to a commitment to specific bandwidth utilization over the lifetime of the system, approximately 25 years. In reality, with demand exceeding capacity sometimes even before installation was completed, this need for committing to capacity has all but disappeared in system development. However, in that traditional model where the carrier-partners linked their investment directly to their capacity needs, they also tied up their investment capability in these long-term commitments. As a result, traditional resources could not raise sufficient capital to meet the demands for new system development.

Into this opportunity vacuum has stepped two new communities of investors with the ability to put hundreds of millions of dollars of capital into the development of submarine cable systems. Their presence is rapidly changing the industry norms.

3a. Private Entrepreneurs

Perhaps the most radical change in how submarine systems are built and owned is the small but growing role of private entrepreneurs. Although private cable systems are currently in the distinct minority compared to consortium based systems, there is a growing trend in favor of private investor-based submarine cable systems. In barely over a year, the number of private cable systems has almost tripled, growing from six to 16.

Seeing the rise of the private entrepreneur one sees a complete turnaround in the way submarine systems are financed, owned, operated, and sold. Rather than the exception, expect these to be the models for future development. In less than a decade, the industry has evolved from an exclusive club to a global game in which any number can play. This essentially eliminates the pivotal role of the carrier as system owners and/or participants.

3b. The Regional Operating Companies

In addition to private entrepreneurs entering the market for the development of submarine cable systems, the second largest community of investors that have emerged and have had a tremendous impact on the industry are the Regional Bell Operating Companies (RBOC), General Telephone and Electric (GTE), and Sprint/United. They are the nine powerful telcos that are equivalent in size and capabilities of any national telephone company anywhere on the globe. Until the *Telecommunications Act* and under the *Modified Final Judgment* (MFJ) consent decree that dismantled the Bell System in 1984, the roles of the RBOCS especially were territorially and functionally limited by law and regulation. All nine companies are cash rich and need to diversify away from their slow-growth domestic telecom businesses and seize opportunities to enter high growth international markets. The submarine cable business is one such opportunity.

The influence of the RBOC overseas activities on projected submarine cable systems forecast for between now and the end of the decade will tend to move projects forward. This effect is likely to move approximately 30,000 km from 1998 planning period to 1997 implementation.

In the new investment mix, expect to see these regional operating companies attempting to connect their growing international interests which include both network and wireless telephony, data, and cable TV to the global information network. This will involve active investment in submarine fiber optic cable systems which incorporate SDH broadband capabilities.

4.0 Technology-Driven Explosive Demand

To say that advances in technology drive the evolution of cable systems has become cliché. Expressions usually become cliché because they are true. The truth of today's technology story is two sided. The other side is demand. Technology advances driving demand include multimedia applications, the Internet, and new Low Earth Orbit Satellite (LEOS) connectivity.

4a. Multimedia Applications

On the demand side, technological advances in multimedia applications have generated exponential growth in the need for bandwidth. High-resolution, full-color graphics, real-time video conferencing, high-fidelity audio information, high definition television: these are a few of the multimedia applications rapidly taking over information requirements in research, business, education, government, and consumer entertainment. These are all hungry consumers of bandwidth. Moreover, with growing trends toward telecommuting and home offices, toward shifting work where the labor supply is plentiful and cheap, and away from the megabusiness as the major employer of today's work force, there are virtually no limits to where bandwidth demand is growing. People around the globe need bandwidth to connect domestic institutional facilities, homes, and offshore facilities. These rapid increases in bandwidth requirements represent demand-side technology changes that influence fiberoptic cable system growth.

4b. The Internet

Speaking of clichés, here comes the Internet. Facilitating the rapid exchange of bandwidth intensive multimedia applications is the explosive growth of the Internet as an international network of networks, giving users around the world easy access to information in a variety of formats. A parallel development, thousands of enterprise-specific Intranets are coming along to combine with the Internet to place increasing demands on carriers and cable owners for large increments of bandwidth on demand. Once, not so very long ago, this type of traffic was among that labeled "other than voice." It accounted for about 10% of the volume of voice traffic. Now it is rapidly becoming the predominate driver of bandwidth demand on global networks.

What is it about the Internet that has caused its explosive use in the last five years or so? Part of the explanation includes the rise of multimedia applications on personal computers. Instead of relying on text and data-only information, users are discovering they can enhance their presentation of information with richly colored graphic images, video images, and high fidelity sounds. In turn, they can use global networking to transmit these multimedia displays to their counterparts elsewhere in the world. This relates to the concept of unified corporate cultures to be discussed in the rise of the MNCs below. Another part of the explanation focuses on the robust nature of internet technology: regardless of traffic volume or network failures, service across the networks is virtually assured. Even under the most demanding circumstances, as long as a host site is available, the user can connect experiencing only graceful degradation of service usually reflected in slower transmission rates.

To understand the Internet requires the concept of multiple services over a common infrastructure using common IP/TCP protocols. Within this network of networks, one can have access to electronic mail transmission and receiving, telnet remote computing on a host processor, gopher research services, FTP file transfer services, and internet relay chat text-based conferencing. In 1990, the world wide web came on line with ability to integrate all these capabilities plus multimedia page definition that includes complex layout and design, graphic images, sounds, and video. The birth of the world wide web saw a real explosion of growth in host computers that comprise the Internet. Compound annual growth was about 95%, almost doubling each year. Today there are 9.5 million host computers connected to the Internet.

Today's exciting new applications include Internet Phone and CU-CMe teleconferencing. Although neither of these applications will replace telephony or broadband teleconferencing services in their present stages of development, they herald radical changes in telecommunications of the future giving end users greater control over the networks and the ways in which they use them. Although such technological developments portend trouble for providers of specific communications services, they auger well for carriers and submarine cable operators. These new integrated services will continue to consume bandwidth across national boundaries and across the deep blue seas.

4c. Low Earth Orbit Satellite Systems

The introduction of LEOS systems in the coming year might look as if they might cut into the market for submarine systems. LEOS introduces a whole new mode of wireless communication. Instead of competing with cable, it will increase demand. When coupled with solar energy capabilities, a LEOS terminal can provide connectivity to any corner of the world wherever the sun shines for part of the day and a satellite hovers overhead. All that will do is expand the market for telecommunications by instantaneously enhancing teledensity in those nations most deprived of connectivity due to geographical or economic barriers. With new-found connectivity will come economic development, creating new markets thereby increasing economic opportunity domestically and with trading partners anywhere in the world.

5.0 Impact of Business and Political Globalization

All of these increases in global communications support today's trends towards the globalization of business, especially through the rise of multinational corporations. This paper has pointed out synergistic relationships in which it is difficult to separate the cause from the effect: the breeder reactor model. The impact of the globalization of both business and politics continues to support that model.

Global businesses needs global communications. To function effectively, MNCs need instantaneous and ubiquitous access to information. Wherever their influence extends and regardless of the cultures in which they operate, successful MNCs rely on maintaining a unified corporate culture. Central to a unified corporate culture is the premise that information is a corporate resource available to all. Moreover, the MNC must maintain its information resources consistently available in standardized formats in order to sustain productivity across the entire corporation. Thus, the presence of a global network creates an environment for the globalization of business.

The same holds true in the political sphere. Government behavior in geopolitics imitates business behavior in global business, including its telecommunications needs. Hence, the need to maintain instantaneous and multimedia communications.

Thus, as global business and geopolitics continue to thrive on communications, the growing needs of these entities for global connectivity and greater bandwidth continues almost unabated.

6.0 Conclusion: Change is Growth

Around 1994, the submarine cable industry began to predict a tapering off of growth in new systems to occur sometime in the late 1995 or early 1996. Rather than seeing that tapering off materialize, in 1996, we saw projects planned for later in the decade move forward.

Where and when will it all end? We seem to be moving along the uphill side of the curve, and the real climax does not appear to be anywhere in sight. The changing forces driving this growth are synergistic and symbiotic, feeding off each other to fuel further growth. By its size and scale, the industry has created an attractively rich environment for outside investment. Outside investors, i.e., those entities not among the traditional submarine system owners and operators, not only can get into the business easily, but in many cases must get into the business to provide the financing needed to sustain the industry's rapid growth. As such, the presence of outside investors almost ensures that the undersea cable business can meet the capacity and connectivity demands of users and carriers quickly, and reliably. These attributes, in turn, make undersea cable systems more competitive than the costly alternatives of satellite transmissions, thus ensuring continued growth. An old proverb reminds us that the more things change, the more they remain the same. In the undersea cable industry, ongoing change continues to be the story of the future.

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Into the information age with submarine cable systems

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Abstract

Submarine cable systems, owing to such features as high capacity, high transmission quality, high reliability and cost-effectiveness, are ideally suited to the requirements of incumbent or emerging global telecommunications operators, which need to control the architecture, diversity and cost of their network infrastructure, and feature a global range of services to be able to play a role in the emerging global information society.

Introduction

"Global" is definitely one of the key words at the turn of the century. It applies to most sectors of human activity, economic, scientific, political, social, entertainment, and has a major direct or indirect impact on every person's life. As economic markets tend to become global, and as economic and social interaction nowadays occur on a world-wide scale, participating to an efficient and ubiquitous information infrastructure is an essential factor of development for all communities around the world.

Various resources are available to achieve this goal, among which are submarine cables, satellite links, terrestrial cables and microwave systems. Far from competing with each other, all these resources can be combined in a collaborative and complementary way, leading to a world-wide global network, that will form the backbone of future information highways.

The Information Highway infrastructure features specific requirements, including high capacity, excellent availability and uncompromising reliability of network connections, and submarine fibre optic cable systems are essential constituents of the global telecommunications infrastructure being developed around the world.

Evolution of the telecommunications industry

Global everywhere !

The single major factor affecting the telecommunications industry is "globalisation". It finds its roots in the tremendous technological progress that has enabled many new types of services and applications never deemed possible before. Among these, we can cite high speed communications and computer data transfer, at rates that have increased by several orders of magnitude, world-wide and seamlessly integrated networks, video-conferencing, mobile communications, Internet, etc.

The variety, scope and reach of these new offerings have contributed to tear down national frontiers and to push carriers and service providers towards considering a global offering and a global customer base. The telecoms market is now considered to be world-wide, and no single country can hope to develop its telecoms infrastructure and services in isolation of its neighbours and correspondents.

This international pressure bears implications on purely national —at first glance— issues, such as the role of government agencies, competitive regulations, universal service, etc. As a result, most countries are moving from a state-owned monopoly for telecommunications operations to a regulated competitive environment, with a plurality of operators and service providers, mostly privately owned and with some proportion of foreign capital. The justification for these changes is that regulated competition is beneficial for the end-user, in terms of better service at a lower price.

However these structural changes have a profound effect on the economic and social aspects of the telecoms industry. Giant entities are being created, as existing and new operators try to join forces to enlarge their customer base, increase their investment capabilities and improve their competitiveness through economies of scale and global presence. This results in increased business focus —i.e. bottom-line orientation—, massive staff reductions and re-evaluation of development strategies.

The fast-changing environment creates a perceivable sense of uncertainty in long term forecasts of demand and corresponding supply requirements. The combination of all these factors has led telecommunications operators to seek new ways of financing the capital-intensive development of network infrastructure, essentially by trying to share market risk with new categories of partners, such as financial trade houses, or even system suppliers.

A technology-driven industry

Another crucial factor to understand the evolution of the telecommunications industry is the sustained pace of technological progress. Many new services —such as virtual networking, Internet services, ATM switching, computer connection and data transfer, interactive and real-time video transmission, etc.— have only become possible with the advent of reliable, high quality, high bandwidth and professionally managed transmission capabilities.

The three obvious areas where technological prowess is prominent are mobile telephony systems, satellite systems and submarine cable networks. However, for the average person, the perception of the rapidly changing world of telecommunications is heavily slanted towards the high-tech and space-age image of satellite systems, nowadays associated with mobile personal communication services. With the associated icons of rocket launches and out-of-reach orbits of satellites, satellite telecommunications benefit from a scientific and futuristic glow, and clearly seem to represent the future of human communications.

Nevertheless, the deep sea world also holds its part of unexplored potential and mysterious life, and most people are unaware that high technology also shines beneath the ocean surface, and that the information society relies —and will continue to rely— on submarine fibre optic cable systems to form the backbone of a world-wide network.

Submarine cable transmission is an area where astonishing progress has been made over the last fifty years. Figure 1 illustrates the exponential increase in capacity over this period, obtained through improvement of existing technologies, as well as step changes at ever shorter intervals.

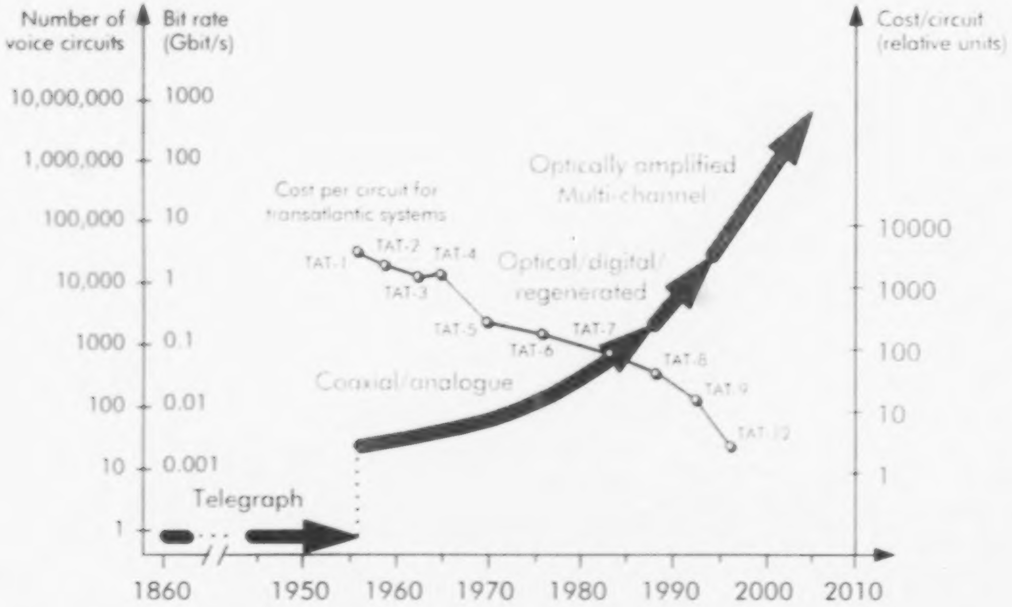

Figure 1 . Evolution of submarine cable system capacity and cost

While the first generation of submarine cable systems lasted over a century—telegraphic systems, with a very low capacity of one channel, with maybe a few symbols per second—, new technologies are being developed at an increased pace: first analogue systems using copper-based coaxial cable and electronic repeaters, then digital systems using optical fibre and opto-electronic components.

Since the advent of fibre optic submarine systems in 1988, operating at 280 Mbit/s (4000 telephone circuits), the capacity of submarine systems has been multiplied by 16 (5 Gbit/s in 1996, using optical amplification), while in the same time the life-span of a technical generation has been shortened by a factor of two. Nowadays a product generation lasts only about two to three years, while it takes about 4 to 5 years to develop it. The current technical generation (planned for service in 1998) has a design capacity of N x 2.5 Gbit/s (N = 2 to 8), using multichannel transmission (Wavelength-Division Multiplexing, or WDM) technology. These systems provide a modular capacity of up to 20 Gbit/s per fibre pair. At the current pace of progress, it is anticipated that a capacity of 100 Gbit/s (over 1,200,000 telephone circuits) will be reached by the turn of the century, and that 1 Tbit/s capacity (12,000,000 telephone circuits on a single optical fibre!) could be available before year 2005.

The evolution of submarine systems' capabilities is essentially driven by technology capabilities, which in turn promote progress in the range of services offered, thus stimulating stronger demand in system capacity.

Simultaneously, as the major cost constituents of implementing a submarine cable system are more or less fixed—mobilising cable ships for laying and repair operations, submarine cable, civil works for terminal stations, hermetic housing for repeaters or branching units—, the global cost of a submarine cable system is almost entirely determined by the length of the system, and depends only weakly on the system capacity and transmission technology. Hence, given the steady capacity increase over time, there is a corresponding regular decrease of the cost per circuit on long distance submarine systems, divided by more than 1600 over the period from 1956 to 1996. This cost decrease benefits almost entirely system owners and end users.

These cost-efficiency features explain, when considered together with the high quality of optical fibre communications, why submarine cable systems are now considered as the preferred means for international connectivity, as required for the information superhighways.

Specific aspects of the submarine telecommunications industry

It's a small world !

Indeed, various elements contribute to making the submarine cable industry a sort of closed community.

First, one must not forget the prime feature of a submarine cable system: it has much, if not all, to do with the sea, as a general concept. As early as 1850, telecommunications engineers started to design cables for use in a sea water environment, to invent adequate marine cable-laying procedures, to construct specialised cableships. This was the beginning of a long history of submarine cable undertakings, and a new fraternity of specialists was born. This fraternity sense of the submarine cable industry community is still very much alive and active today, as very specific technical and operational problems have to be addressed, which require well-trained staff, special-purpose vessels and very specific reliability concerns — and corresponding solutions.

Second, apart from domestic systems linking only landing stations within a single country and operated by a single carrier, the vast majority of international submarine cable projects are based upon bilateral or multilateral agreements between corresponding carriers. In addition, all submarine cable systems bear some relationship with neighbouring systems, as they need to implement mutual restoration and to co-ordinate marine maintenance activities. This leads to a good degree of mutual understanding between operators throughout the world, and to a general knowledge among the community of current and upcoming cable projects, at least for the big projects. Additionally, this necessary co-operation helps to "organise" the development of the global submarine cable infrastructure, as many discussions between a large number of partners are part of any project's development agenda. Without such a consensus, chaotic development of network infrastructures could result, with adverse effects on the global efficiency of international telecommunications networks.

Third, given the accelerated pace of technical progress, and the increasingly demanding financial weight of "high-tech" research and development, only big players can support the scale of effort required, on the supplier front at least. Therefore the "community" paradigm appears once more, where competing suppliers actually have an interest in developing compatible product lines, conforming to agreed industry standards, so that technical risk is shared within the community and system performance can be guaranteed to the end customer. Another incentive for evolving technical generations in a "synchronised" way between suppliers has arisen from the increasing complexity of the networks now being planned. For example, the SEA-ME-WE-3 project, which will link Europe to Asia, through the Mediterranean and Middle East, will total about 30,000 km of cable, with close to 40 landing stations. This is achieved owing to the new WDM technology, which significantly enhances connectivity and networking flexibility in submarine cable networks, by potentially assigning independent optical channels —colours, or wavelengths— to each communication path between any two landing stations. Obviously, such a project requires co-operation between operators —almost 80 of them in the SEA-ME-WE-3 project— but also between system suppliers, as it would be difficult for one supplier alone to cope with the technical and operational challenges of implementing such a large project in the required time scale.

Cycles are what life is about !

Up to now, every time a new generation of submarine cable system technology was introduced, all major routes were upgraded to the new standards within a fairly short period of two to three years, and the installed capacity was considered largely sufficient to satisfy demand for about a decade. Hence planning of new projects was put to sleep, until network planners realised that demand had increased much faster than expected, by which time a new generation was usually ready to be launched, for the next cycle to begin.

Network planners have consistently proven very pessimistic in their estimate of future requirements, and their task is now made even harder by the explosion of the Internet, which defies, at this time, any serious forecast. Indeed, Internet growth is in the exponential part of the S-curve, and nobody can predict accurately when it will start to slow down.

However, for the next two to three years, after having experienced one of the periodical troughs in demand for submarine cables, which lasted over most of 1995 and 1996, demand is picking up quickly now, as major projects are about to be launched, and many are on the drawing boards, all of them to be implemented between 1998 and 2000.

Technological evolution: decreasing customer drive — increasing supplier responsibilities

As a result of some of the considerations developed above —difficulty in forecasting future demand, increased bottom-line awareness, vanishing government support, to name a few—, it appears that operators are backing out of actively supporting research and development, and are relying increasingly on system suppliers to take the lead in defining the future technological generations.

Not only must system suppliers self-support the development of increasingly complex products, but they must also now define what products will be needed and when.

In addition, the responsibility of thorough qualification of new components and products now lies clearly in the hands of suppliers, and contract terms reflect that new approach, with increased safeguards for operators regarding satisfactory performance of systems during their operational life.

Hence it is of paramount importance that the market and customer-supplier relations adjust in a way that will ensure that suppliers have the potential to build systems that will fully satisfy the requirements of future networks. This means establishing a marketplace where every party is wilfully contributing to the global infrastructure development agenda, while being able to achieve its own steady development targets.

Financing submarine cable projects

Because of the very large financial scale of international submarine cable projects and the growing uncertainty in the future —dizzy forecasts, strategic upheavals, political adjustments— many international operators are reluctant to commit a high level of long-term financial resources to submarine cable projects. Therefore they are more than willing to share the burden of promoting and implementing projects with other partners. These partners can be financial houses or capital investors looking for telecoms projects with a high return on investment.

The only reason why operators would be willing to commit mostly their own resources for financing a given system is when they consider it as a strategic piece of their network infrastructure, over which they have to retain full control. However, even in such a case, an increasing pattern is to involve system suppliers in the financing scheme of telecoms projects, through basic supplier credit, deferred payments or even by asking them to invest capital in the projects.

Peeking into the next century

Internet as a model for future development ?

For the submarine telecommunications industry, the major event of the last twelve months has been the acknowledgement of the importance of the Internet as a prime driver of network evolution. Internet requires high bandwidth, high quality and highly reliable communication channels, and since business and private users have started to realise the potential of Internet applications, this has led to a rapid surge in demand and network usage. Once the hype surrounding the Internet dissipates, corporate user groups will probably be the most heavy users of Internet resources, if only for Intranet co-operative work. They will impose a heavy load on existing infrastructures, that will probably require a global re-evaluation of network development strategies.

Several of the major projects initiated in the last few months actually found a strong justification in increasing Internet traffic, which will account for more than half of international traffic on certain routes from 1997 onwards.

In addition to being a driver for traffic demand, Internet is also considered by some as a model for future co-operation between players in the telecommunications industry. The Internet grew out of a collective effort by American defence agencies, universities and research laboratories to set up a decentralised network, with a sense of global interest being the prime driver for its operation and administration. The fact that the Internet is now used for commercial purposes will undoubtedly impose some rethinking of its structure and organisation, but its collective development philosophy should not be dismissed altogether.

Developing the global information infrastructure

In the near to mid-term future, the world-wide network will expand significantly, serving areas previously not connected and upgrading existing routes to the current standards. In that respect, quite a number of big international submarine cable projects have been identified for the next four years, which will provide global connectivity at high capacity to virtually every country in the world.

These projects, such as SEA-ME-WE-3 (Europe to Asia, through the Mediterranean), GEMINI (trans-atlantic ring network between the UK and the US) SAFE (South Africa to Malaysia) or Atlantis-2 (South America to Africa and Europe), are very significant undertakings, with installation schedules spanning over 2 to 3 years, and mobilising financial amounts of several hundred million dollars.

When the world-wide fibre optic network reaches the expected status of maturity, the information superhighway will be in place, as far as the backbone infrastructure is concerned, but this can arguably only be achieved through a co-ordinated effort of the whole telecommunications community. This applies in particular to the submarine telecommunications industry, which is a capital-intensive area and where efficient use of resources is a must.

Conclusion

We have outlined in this paper a few important factors affecting the direction of the telecommunications industry. The major driver is globalisation, which has a definite impact on regulations, strategies, markets, services and technologies. Building the information highway of the next century will definitely be a global effort of the telecommunications community, and every constituent of this community has a role to play.

In particular, the submarine cable systems industry will be an integral part of this development strategy, and all its actors must have an understanding of the challenges facing them in the next decade, if harmonious development of the network is a common goal to be achieved to the greatest benefit of the user community.

The FLAG Cable System

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Abstract

This paper discusses the current status of the 27,000km long FLAG submarine telecommunication cable system which is being constructed between Japan and the United Kingdom.

The technical and geographical design of the system, will be described. In addition the author will discuss specific problems observed in the manufacturing and deployment of the cable, amplifiers and branching units. A discussion of numerous reroutes that were required since the initial survey as well as the addition of additional landing points which have been added will portray the increase in complexity that this system has incurred.

A discussion of the quality assurance activities that are underway to insure long term reliability of the system will be included in the presentation together with a synopsis of the quality assurance difficulties encountered to date will be included.

In addition the author will discuss the results of the inter-working tests conducted to date, together with the results of the sub-segment commissioning tests.

Finally, the author will report on the status of the development of the network management system which will provide a unique scheme of monitoring, controlling, and insuring the high reliability objectives of this system.

Introduction and System Description

The FLAG Cable System was termed by the editors of the "IEEE Spectrum" as the longest man made structure in the world in a recent issue addressing Mega-Projects. As it was initially configured in December 1994, it was approximately 27000 Km long and landed in 11 countries, with two landings in Egypt and Thailand where the cable crossed the African and Southeast Asia land masses.

Since that time, additional landings have been added at Nan Hui (Shanghai) China, Ninomiya, Japan and Jeddah, Saudi Arabia which have increased the overall cable length by approximately 1000 Km.

The Cable System consists of two fiber pairs each carrying 1558 nanometer infra-red light signals modulated at 5.3Gb/s. The light is periodically amplified using erbium doped fiber optic amplifiers which are very simple devices of proven high reliability. Overall the final cable system will contain 340 repeaters. The configuration shown identifies the location of branching units.

Each 5.3Gb/s signal contain two bit interleaved STM-16 signals together with overheads which carry additional bits designated for forward error correction which provide increased immunity to noise and other impairments. The basic STM-1 and STM-4 pay loads meet all ITU recommendations for Synchronous Digital Hierarchy (SDH).

It has been advanced elsewhere that the availability of broadband SDH building blocks is necessary for binding together the growing world-wide information infrastructure.

In order to understand the importance of SDH fiber optic submarine cable in this regard, I have attached the following table which shows the submarine SDH connectivity for the FLAG system and which emphasizes the importance of the submarine cable systems for the world wide growth in the information infrastructure. (See Table I attached.)

Status

The project to install any cable system can be divided into Manufacturing, Installation and Testing/Commissioning. Currently the Manufacturing is almost complete. At this time almost all of the cable, amplifiers, branching units and terminal equipment is manufactured.

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The Installation phase of the submarine cable is very active at this time. As I speak, two vessels are performing post lay burial inspection and four ocean going vessels are either loaded with cable and in transit to lay, or are laying cable. All ocean going laying activities will be completed by May 23rd and post lay inspection and burial is scheduled to complete on June 30th with the exception of the Jeddah branch. Terminal equipment already is 80% installed and completion of this will be achieved in late May (with the exception of the Ninomiya and Jeddah branches.)

Finally all the subsystem Testing and Commissioning activities which has already commenced in the Mediterranean Sea sub-system between Palermo and Alexandria, will be completed by July 25, 1997. This will allow sufficient time for overall system commissioning so that we can meet our goal of Provisional System Acceptance (PSA) on September 6, 1997.

Changes and Modifications

Added Landings

While the base system is relatively complex, the addition of three additional landings since the system was designed has necessitated involved negotiations with the landing parties, survey companies, suppliers, and lenders. FLAG has carefully studied the addition of such landing parties and has only agreed to them if:

(1) The addition did not decrease system reliability.
(2) The complexity of the system did not make the overall project unmanageable.
(3) Base system RFPA was not affected.

In addition, other modifications to the original design have also added to the complexity of the original design. Some of these include: additional pipeline crossing not identified in the original marine survey, changes to landing point locations, increased fishing activities which necessitated more armoring, revocation of routes due to military activities, fishing unions refusal to grant approval. Many of these required quick re-surveys and rapid negotiations with suppliers as well as survey companies, lenders and other bodies.

Quality Assurance

Quality assurance activities are multifaceted and stretch from the manufacturing, through the installation and commissioning phases. Many of the quality assurance activities are part of Project Management's need to perform due diligence in order to insure that the purchaser is receiving the contractually defined high reliability products that are required to achieve the 25 year life of the system. However, our quality assurance activity actually became a joint collaborative effort with the suppliers which ensures that:

1. The equipment purchased exceeded our performance and reliability objectives.
2. The equipment contains a minimum number of flaws that require field modification.
3. The marine installation provided maximum protection to the cable and that all mechanical handling events are cured during the marine installation phase.
4. The terminal equipment is installed in such a manner to minimize opportunities for long term reliability problems.

The type of problems observed and jointly corrected included procedural, workmanship, functional definition, processor lock-outs and cable handling errors. I would like to stress that these activities can not be classified as policing of the supplier but instead was a genuine collaborative effort between the supplier and FLAG quality assurance to ensure the highest possible system reliability.

Inter-working & Commissioning

Inter-working, tests have only just begun at a laboratory in Holmdel, New Jersey and to date the number of results are limited. The first sub-system commissioning tests are underway as I speak. The results will be presented on a real time basis.

Network Monitoring

FLAG is installing a state of the art Network Operation Center in Fujairah, UAE. The surveillance network consists of LANs in each landing station linked via the embedded data communication channel (DCC) contained in the STM-16 level of SDH overheads. These are connected in a daisy chain manner to the center in Fujairah.

In order to provide necessary surveillance system reliability, these in system links are backed up by out of system private lines and in certain locations primary rate ISDN lines for back up.

Summary

The longest man-made structure on earth is proceeding on schedule to meet an RFPA date of September 1997.

It is designed and product managed to meet stringent reliability and performance requirements that not only support traditional telephony but also the growing requirements for the international infrastructure.

Table I

Country	In-Station SDH Connectivity	In-Country SDH Connectivity	Direct Connectivity to
UK		Celtic, Tat 12/13, Rioja, CANTAT III, Germany, France 4/5	US, Canada, Spain, Ireland, Iceland, France Belgium, Faroe Island, Channel Islands, Germany
Spain		Rioja, Barcelona-Savona	UK, Italy, Denmark
Italy		Columbus 2, Barcelona-Savona	Spain, US, Virgin Islands
Egypt	Aletar		Syria, Lebanon
Saudi Arabia			
UAE		FOG	Bahrain, Kuwait, Qatar
India			
Malaysia		APCN	Singapore, Philippines, Indonesia, Thailand, Australia, Taiwan
Thailand		APCN	
Hong Kong	APCN		
PRC			
Korea			
Japan	TPC-5	APCN	US, Guam

THE INTERNET AND TELEPHONY: THE IMPACT OF UNDER CONTROL OR TECHNOLOGY ON TRADITIONAL TELEPHONY REGULATION

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1. ABSTRACT

The clash between low untimed Internet usage charges and timed PSTN telephony challenges the fundamental paradigms of telephony regulation. The carriers have legitimate concerns that Internet telephony threatens their substantial investment in PSTN infrastructure. Equally, ISPs and Internet users also are legitimately concerned that any departure from the Internet's basic philosophy of untimed charges to protect PSTN telephony will imperil the Internet itself. Given the highly decentralised nature of the Internet, traditional regulatory tools are unlikely to be successful in resolving this conflict, and a more fundamental reckoning is required between Internet telephony and PSTN telephony charging.

2. INTRODUCTION

The Internet's capability to provide voice telephony anywhere in the world for the cost of a local call has the potential to turn the telecommunications industry, and its accepted regulatory paradigms, on its head. The US telecommunications carriers have responded by petitioning the FCC to have telephony regulation extended to providers of Internet telephony software, stating in their petition as follows:[1]

> *"This petition concerns a new technology: a computer software product that enables a computer with Internet access to be used as a long distance telephone, carrying voice transmission, at virtually no charge for the call. ACTA submits that the providers of this software are telecommunications carriers and, as such, should be subject to FCC regulation like all telecommunications carriers."*

However, extending the traditional body of telephony regulation to Internet telephony would be technologically difficult, an overly simplistic policy response and potentially retrogressive for the development of the Internet generally. Equally, carriers have soundly based concerns about the impact which current Internet telephony pricing will have on a substantial investment which they have made and will need to continue to make

The telephony capability of the Internet presents three main challenges to traditional telephony regulation, as follows:

in the PSTN. A more fundamental reckoning between PSTN and Internet telephony is required.

The Internet fundamentally changes the dynamics of regulation. The traditional response within the telephony world to challenges to the accepted order is to regulate or even prohibit that challenge. As the pace of technology increased, the regulator's task has been likened to the little boy plugging holes in the dyke. However, to stay with a watery metaphor, the Internet is as inevitable and overwhelming as the incoming tide which confronted King Canute, and renders the traditional approach of regulation and prohibition futile.

It is easier to regulate alternative telephony providers where the service is provided through a switch operated by the service provider and is supplied and promoted by that service provider as a single, identifiable and finished product to the end users.

However, there is very little on which to "fix" telephony regulation when the calling functionality is distributed to the equipment of individual end users, that functionality is only one of a range of desktop features and the role of the external provider is limited to developing and supplying the relevant enabling software (which usually will be developed and sometimes supplied beyond the jurisdictional boundaries of the regulator).

- *bypass of telephony regulation*: carriers usually are subject to extensive regulation, even (or perhaps more accurately, particularly) in an environment of competing carriers. The obligations of universal service, which are formally or informally funded out of the national long distance and international revenue streams, are most vulnerable to Internet telephony. The carriers also may be subject to rules or requirements concerning tariffing and retail pricing, and the asymmetric application of these rules between PSTN voice and Internet voice can impair the carriers' competitive response to Internet voice. Where governments have restricted the number of basic voice providers, such as a monopoly, a duopoly or an oligopoly, voice bypass on the Internet threatens the value of those restricted carrier reservations and therefore the government policies sought to be achieved;

- *inconsistent access pricing:* competing PSTN carriers are required to pay a cost based access price to utilise the local network of the incumbent. Internet service providers are able to utilise the carrier local networks either for free or on the basis of their customers paying a flat, untimed calling charge, again creating substantial competitive asymmetries between ISPs and traditional PSTN carriers. The competitive risks can be exacerbated where the incumbent decides to pursue ISPs or provide its own retail Internet services at flat, untimed charges while leaving the PSTN carrier which acquires access services from the incumbent "trapped" in a timed PSTN interconnect charging framework; and

- *telephony arbitrage:* Internet voice provides ISPs not only with the traditional opportunity to aggregate multiple end users' traffic on carrier leased capacity, but also substantial additional arbitrage potential through voice compression. Most regulators have been managing, such as through differential price caps, a rebalancing of switched and leased PSTN charges. If the process of PSTN rebalancing is not sufficiently advanced, significant distortions could be caused by the greatly enhanced arbitrage opportunity presented by voice compression, including over the Internet.

3. COMPARISON BETWEEN THE INTERNET & PSTN TELEPHONY

The different infrastructure architecture and technology employed by the PSTN and Internet telephony has profound implications for the regulation and pricing of the various services.

The PSTN connects callers through 2 basic networks: the local exchange; and inter-exchange networks. When a caller picks up her phone to make a long distance call over the PSTN she uses the local loop which are the lines connecting her home to the local exchange. The switch then determines over which communication path the message should travel. Long distance calls are directed toward the point of interconnection with the inter-exchange networks. The call is then routed through various networks to make the connection. Telephony through the PSTN uses circuit switching which establishes a call path and keeps it open for the duration of the call.

By comparison with PSTN technology, Internet telephony relies packet switching. Each transmission is broken down into 'packets' that contain the address of where the communication is heading. Because the networks that form the Internet are interconnected at various points, the most efficient route may vary from second to second. The use of packet switching allows each packet of data to be routed according to the most efficient route. Consequently, the various components or packets of an Internet transmission may take vastly different routes to their destination. So when an end-user transmits data, it is sent out onto the Internet, disbursed, routed across many different telecommunications facilities, and then reassembled at the Internet address of the recipient.

4. PROBLEMS OF INTERNET TELEPHONY EXISTING OUTSIDE THE ORBIT OF TRADITIONAL TELEPHONY REGULATION

The first and most obvious impact of Internet telephony is the existence of a substitutable product for PSTN telephony outside the extensive telephony regulatory regime. As a result, there is substantial asymmetrical regulation of interchangeable products, which as a matter of both public policy and fair competition must be regarded as unsatisfactory. As the technological capabilities of Internet telephony improve, the dilemma or paradox of this asymmetrical regulation will become more acute.

4.1 THE UNITED STATES

The FCC, including in its access determinations, has drawn a distinction between plain old telephone services (POTS) and enhanced services (ES). The FCC has defined ES as the "use of the existing telephone network to deliver services other than basic transmission, such as voice mail, email, voice store-and-forward, fax-store-and-forward, data processing and gateways to on-line databases".

The FCC treated the Internet as a whole as an enhanced service. Though many features and services within the Internet are, or resemble "traditional" online services, such as the World Wide Web, the Internet also has features and services which or closely resemble traditional PSTN services, such as email substituting for facsimile, and increasingly two-way, real time services like Internet voice.

The most significant practical outcome of this regulatory approach is that ISPs are free of the local access fee. Further, Internet telephony providers, be they ISPs or the software providers themselves, are not required to contribute to the Universal Service Fund or collect state taxes.[2]

With the passage of the *Telecommunications Act* 1996, the question of the FCC's regulation of the Internet has arisen again. The *Telecommunications Act* has two specific statutory aims:

- to promote competition in such a fashion as to reduce costs and improve service provision; and,
- to facilitate the rapid deployment of emerging and advance telecommunications technologies.

The carriers feeling under threat from Internet telephony argue that the first objective requires the FCC to extend its regulatory net to the Internet. ISPs and Internet telephony software developers argue that the second objective applies directly to the Internet and requires the FCC to maintain the regulatory status quo.

This dispute came to a head in March 1996 when the ACTA filed with the FCC a petition seeking that the FCC do three things:

- make a declaratory ruling to the effect that the existing body of telephony regulatory control should apply to long-distance and international telecommunications facilitated through the Internet;
- grant special relief to ACTA members by banning the sale of Internet telephony facilitating software, so as to maintain the status quo; and,
- issue a rule-making declaration, defining permissible communications over the Internet.

In general, the ACTA would like to see the Internet regulated as per the PSTN. That is, requiring Internet telephony providers (including software manufacturers) to file tariffs and pay access charges.

The suppliers of Internet telephony have argued in response that the ISP or the software provider is not supplying a telecommunications service in the ordinary sense but only a piece of software no different to other Internet software such as a web browser or computer software generally. They have argued that the ACTA's proposition that the software providers are carriers is the same as arguing that Panasonic should, as a producer of telephones and faxes, be regulated as a carrier or that manufacturers of envelopes should be regulated as private postal authorities.

As with the ACTA's argument, these analogies also are oversimplifications because the software is supplied by the ISP or supplied to be used with the service provided by the ISP. Carriers used to supply handsets as well as the telecommunications carriage service, but no-one would argue that since deregulation of customer premises' equipment the carriers are no longer providers of telecommunications services just because the handset which processes and converts voice for carriage over the PSTN is no longer necessarily supplied by the carrier.

Interestingly, not all bypass long distance carriers actively participate in ACTA. The organisation represents, as at publication, 167 long distance telecommunications companies, including Sprint and MCI (who are non-voting members). However, AT&T is not a member and appears to be following a different strategy in response to Internet telephony. Apparently on the basis that "if you can't beat them join them", AT&T has joined with America On-Line to establish a venture called "World Net" which will compete in the provision of Internet telephony.

The ACTA's petition, at publication, has not been decided but early indications from the FCC do not bode well. Its Chairman, Reed Hundt, has stated that:[3]

> *"I am strongly inclined to believe that the right answer at this time is not to place restrictions on software providers, or to subject Internet telephony to the same rules that apply to conventional circuit-switched voice carriers. On the Internet, voice traffic is just a particular kind of data, and imposing traditional regulatory divisions on that data is both counterproductive and futile."*

In the battle between the first and the second objectives of the 1996 Act, it seems that the Chairman favours the second when dealing with Internet technology. He continues:

> *"...We shouldn't be looking for ways to subject new technologies to old rules. Instead, we should be trying to fix the old rules so that if those new technologies really are better, they will flourish in the marketplace."*

4.2 HONG KONG

In Hong Kong the supply of Internet gateway services is subject to licensing under a PNETS licence which is available on application and is analogous to a class licence. A plethora of ISPs have been launched in the Hong Kong market in the last 3 years (in excess of 50 at last count) which is now very price competitive. The Hongkong Telecom Group now has a separate ISP retail arm, Hongkong Telecom IMS which is "ring fenced" from the rest of the Group by licence conditions that ensure that it deals with other Group companies on an arms length basis.

Historically no retail local call charges have been levied in Hong Kong and this practice has continued since the introduction of local fixed line competition on 1 July 1995. As a result, there is a significant cross subsidy between international and local voice services. This is widely regarded as economically inefficient, however, it is recognised that the removal of this cross subsidy will take time. However, local wholesale charges do exist in Hong Kong. For example, Hong Kong Telephone (the local incumbent) charges a PNETS tariff to resellers (including ISPs) that consists of both a line charge and a timed local call charge. Therefore the increasing amounts of local capacity used by Internet subscribers is not contributing to an increase in the implicit cross subsidy between international and local PSTN services.

However, the ISPs local access cannot be converted into commercialised international voice services as a result of the exclusivity of Hong Kong International Limited over external telephony services until 2006. In a paper released in April 1997 OFTA expressed the view that Internet telephony between 2 host PCs was legal but the commercial operation of PSTN gateways was not. While this regulatory distinction is vague it confirms that ISPs would infringe the existing voice exclusivity if they allowed subscribers to call an Internet gateway over the PSTN using an ordinary telephone and the ISP then facilitated the TCP\IP protocol conversion. That is, if the ISPs began to set their own IDD tariffs rather than acting as passive gateways that may be carrying Internet telephony signals generated by subscriber PCs. If PSTN to telephony Internet gateways were allowed then this would have significantly affected the value of the fixed telecommunications networks services licences issued to 3 new entrants in 1995.

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5. PSTN AND INTERNET ACCESS PRICING ISSUES

The problem of arbitrage between the timed retail rates for PSTN telephony and the untimed or flat rates for Internet telephony has been the subject of considerable discussion, as outlined below. However, a more neglected problem is a similar clash between the approach taken by the incumbent local network carrier in pricing access for PSTN competitors and for Internet access.

While there are significant disputes over the appropriate pricing methodology and its application, most PSTN interconnect regimes require the incumbent to provide access over its local network at cost-based prices. Usage charges, in particular, are usually time sensitive because costs are regarded as being time related, such as switch occupancy.

The use which ISPs make of the incumbent's local network is not unlike the use of that network by competing PSTN long distance international carriers. The ISPs establish nodes which customers connected to the PSTN can access on a dial-up basis by PSTN telephony. These nodes are not unlike points of interconnection between the incumbent carrier's local network and the bypass PSTN carrier's long distance and international networks. Like POIs, these ISP nodes can be located in same local calling area as the Internet subscriber or can be located some distance away, particularly in rural areas. In large countries such as Australia, there may be a similar number of Internet nodes and points of interconnection.

The transport service and network configuration on the ISP side of the node usually are quite different from that on the competing carrier's side of a POI, and the ISP will use ISDN frame relay, for example, to carry the Internet traffic to the domestic server or the gateway to the international servers. However, on the customer side of the ISP node, the transport service and network used to carry the Internet traffic will be the same as used to carry the competing carrier's PSTN voice traffic.

The ISP and/or its customer will be charged on a very different basis to the competing PSTN carrier for call origination. If the ISP node is located in the same local calling area, the ISP customer usually will be responsible for the call charges and will pay a flat local charge. However, if a POI is located in the same local calling area as the calling customer, timed origination charge will be payable by the competing PSTN carrier. If the ISP node is located at some distance from the customer, the incumbent carrier may have special Internet access deals or ISPs for Internet customers which permit only a flat charge, notwithstanding that a timed long distance charge would be payable if the call was made over the same distance between two persons. Again, the competing PSTN carrier will pay a timed, distance sensitive interconnect charge to carry calls over the same distance to a point of interconnection.

Three issues arise from the incumbent offering flat priced access for Internet services while retaining timed charges for PSTN access, as follows:

- The competing PSTN carrier will have difficulty in developing its own Internet strategy and offering Internet products in competition with the ISPs and the incumbent carrier's retail Internet operations unless the competing PSTN carrier also can obtain origination on an untimed basis.
- The ability of the incumbent carrier to offer untimed access to ISPs for a service which is substantially the same as PSTN originating access suggests that the PSTN access charge is substantially above costs. Alternatively, the incumbent is cross-subsidising the lower flat access charge to ISPs out of PSTN telephony revenue, including timed access charges for the competing carrier's PSTN services.
- As it is locked into a timed access charge, the competing carrier's ability to respond to the challenge of Internet telephony is limited. The competing carrier cannot compete against the untimed telephony capability offered by an ISP, although both originate their services over the same local network. The incumbent carrier through the ISPs and its own retail Internet business has some strategic response to the threat of Internet

> telephony, even if the economics are quite different to its timed PSTN product.

It is the regulatory practice in Hong Kong to set tariffs for resellers at fully distributed cost and therefore improvements in carrier efficiency are passed on to the resale market. As a result the original per minute PNETS charge of HK$0.09 a minute was reduced to 4.2c per minute in July 1995, one of the lowest timed PSTN tariffs in the world.

The PNETS tariff has not been without its critics. In 1995 a number of ISPs refused to apply for PNETS licences in order to avoid the PNETS charge and regulatory control. However, the Hong Kong regulator (OFTA) enforced the licensing and charging regime, the PNETS charge remains in place and Hong Kong continues to avoid the asymmetry found in many countries between a flat rate local call charge and timed interconnect charges. The timed wholesale charge is passed on to ISP subscribers as a component of their Internet access charges, often being separately quoted and Hong Kong is therefore a user pays system. Because the charges paid by the ISPs are so low there is will be no or a minimal difference between these charges and intercarrier charges. Therefore there is neither an ability for ISPs to arbitrage between wholesale charges nor carriers where vanilla Internet services are concerned.

6. RETAIL ARBITRAGE

There will not be much contest in consumers' minds between high, timed traditional PSTN telephony and low, flat Internet telephony. The "hidden costs" of inconvenience and lower call quality may stem the consumer stampede to Internet telephony in the short term, but if (or as some would say when) Internet telephony capability improves traditional telephony will be knocked over in the stampede.

There are real issues of equity and public policy that can't easily be brushed away. The most obvious extreme case is the telephony ISP reseller whose sole purpose is it is to use the Internet as a low-cost bypass medium around the telcos from which the ISP may well be buying some of the underlying transport.[4]

> *'Arbitrage occurs when there is a discrepancy between price and cost, yielding an opportunity for a third party to profit by reselling. Arbitrage is a market concept...With (telecommunications) deregulation and virtual, end-to-end digital networks (arbitrage) is increasingly viable.*[5]

The savings from the ISP buying leased lines in bulk is a mechanism for simple arbitrage similar to how the long distance reseller industry works. Long distance resellers operate through leasing high capacity lines at T-1 and T-3 rates (in the US) which are considerably lower than if the lines were purchased separately. This arbitrage opportunity exists because the market for high capacity lines is fairly competitive while the market for single lines is not.

The competition between the telcos in selling high capacity line access arises because of the basic economics of the infrastructure concerned. Most of the costs in deploying line or cable capacity is in the labour necessary for its construction. Consequently, through-out the developed world the telcos have installed line capacity in excess of present demand. Given the sunk costs involved it is economic for the telcos to lease this excess capacity at marginal costs.

The arbitrage available through bulk purchases is described as simple arbitrage. However, the Internet presents opportunities for far more complex forms of arbitrage. Unlike the PSTN the Internet does not offer a single homogeneous product. The Internet can be used for a variety of applications: email; facsimile; data; voice or sound; and image transmission. Each of these different uses have different economic value to the end-user and the products compete in different markets. Internet facsimile competes with PSTN facsimile services. The value of data transmission to the end-user will depend entirely upon the use to which the data is put. Access to On-line financial information may be worth considerably more to the end-user that the recreational use of web-surfing applications. While the economic value of different services to the end-user will vary dramatically, and consequently the willingness of those users to pay for those services, the network over which the information is carried does not distinguish the message by its content.

Consequently, an ISP providing high-value content services will pay the same rate for access to telecommunications networks as the ISP providing recreational web access. This dynamic is reinforced by the traditional prohibition on common carriers discriminating between or against similarly situated customers, including resellers or service providers. The practical effect is that the carrier must price the transport service on a uniform basis without regard to the end value of the service provided by the ISP using that capacity. As the transport price will need to be at a level which makes the lower value end product viable, the consequence is that the bulk of the end user revenue for the higher value products falls to the ISP and not to the underlying network provider.

Internet telephony itself also provides savings through compression and efficiency of packet switching. Most Internet telephony applications use compression routing that provides bandwidth savings of a factor of 5 to 50. In addition, because the Internet is a shared network, additional efficiency can be gained.

7. THE PROBLEM OF CAPACITY CONGESTION

The tremendous growth in the number of Internet subscribers and the introduction of "bandwidth hungry" applications are causing major congestion problems on the Internet. This, in turn, has raised the question of the extent to which the flat rate charges from the underlying carrier infrastructure is contributing to inefficient, over use of the Internet and whether pricing is an appropriate mechanism to control congestion. One commentator has described the impact of flat rate pricing on spiralling bandwidth consumption in the following terms:

> *"The apparent free lunch offered by the ability to take first the basic applications of the web, and then such bandwidth hungry applications as audio and video and finally Internet phone has created at least a 500% increase in Internet traffic during 1996."*[6]

For example, at 300 Kbs for a video session on the Internet, it takes only 150 simultaneous sessions to congest a link on the NSFNET, the Internet's major backbone, with the highest speed links. As one commentator has noted:

> *"The congestion created by video is pernicious: it destroys some valuable mechanisms that are part of the Internet's discipline and efficiency. Transmission control Protocols (TCP) is used by host computers to provide a reliable byte stream to the applications that are run by an end-user…Video sessions use UDP (User Data Protocol). Unlike TCP, UDP does not reduce its transmission rate during periods of congestion. The tension between satisfying customers with bandwidth-intensive needs and satisfying customers with low-bandwidth applications cannot be efficiently resolved using current technology."*[7]

FCC Chairman Hundt has said of the congestion problem:

> *"With the number of users and host computers connected to the Internet roughly doubling each year, and traffic to the Internet increasing at an even greater rate, the potential for congestion is increasing rapidly. Moreover at a certain point Internet routers are simply unable to handle the load and will 'drop' packets, causing network brownouts. Such brownouts are already occurring.*
>
> *The increasing levels of Internet use are also beginning to affect the telephone network. Internet usage is placing unexpected demands on local exchange carrier's switches, to the point that switch congestion is threatening service quality for all users, including PSTN telephony.*
>
> *This might not be such a big problem if we had an all-digital phone network that was based on a packet-routing multimedia technology such as ATM. But we don't yet. So the hard question is: if there are costs for upgrading the network to support the explosion of Internet and other data usage, who pays these costs?*

> *The phone companies argue that the absence of usage charges means that ISPs do not provide the revenue to cover the additional costs they impose on the network. I do not know the full answer to this problem."*[8]

Another commentator has expressed despair at the threat which bandwidth hungry services pose to basic philosophy of the Internet, as follows:

> *"New network applications are all tending to require heavy bandwidth in near-real time. One may argue that the impact of the new, specifically real-time, applications will be disastrous: their high bandwidth-duration requirements are fundamentally at odds with the Internet architecture, that attempting to adapt the Internet service model to their needs may be a sure way to doom the infrastructure."*[9]

Internet telephony is less bandwidth hungry than some of the other new applications. However, if there is substantial usage of the Internet for telephony calls in substitution for the PSTN, there will be significant aggregate impact on Internet capacity. Pricing of Internet telephony therefore needs to be addressed within the wider context of pricing of the Internet generally. However, the ISPs are likely to be suspicious that any suggestions for usage-based charges on the Internet are really an attempt to protect the PSTN by removing the attraction of untimed telephony on the Internet.

8. PRICING OPTIONS FOR THE INTERNET

8.1 USAGE BASED CHARGING

The basic role of the pricing mechanism is to lead to an optimal allocation of scarce resources, and to give proper signals for future investment. The mechanism in place should lead to the optimisation of social benefits by ensuring that scarce resources are utilised in such a manner as to maximise productivity in ways society thinks fit. While the economic theory can be stated fairly simply, applying those pricing principles to the Internet is very controversial, including because of the significant interests of the carriers in relation to PSTN telephony.

Usage based charging, by its nature, requires measurement and accounting for usage. Accounting poses potentially difficult technical problems. Internet messages are transmitted using packet switching and because each packet is independent it is inherently ill-suited to detailed usage accounting. For example, a one-minute phone call in a packet network would require approximately 2500 average-sized packets. Further, the network is likely to be able to only reliably identify the originating host-computer of the ISP, and not the calling party.

Consequently, the transaction costs involved in implementing usage-based pricing for the Internet may be considerable. Further, the telco would either charge the ISP with the host-computer, or the telco and ISP would have to establish elaborate and expensive verification systems to identify and bill the originating party.

As one commentator has said of the tagging problem:

> *"Usage based pricing would require the tagging of each packet. The idea of tagging is not new. For example researchers at IBM proposed such an 'in/out' tagging as part of a flow control scheme. Frame Relay has the concept of in/out packets as does ATM."*[10]

8.2 A SMART MARKET

Usage based pricing requires both the measurement of usage but also the allocation of unit costs or prices. Cost-based pricing should ensure economic use of existing infrastructure and give network owners appropriate investment signals. There are three basic approaches to determining unit prices:

- a flat or standard unit price which applies irrespective of the time or type of use (flat usage based pricing);
- variable unit pricing depending upon the network costs imposed at different times (congestion based pricing); or
- variable unit pricing depending upon the economic value of the communication in question (transaction based pricing).

Flat unit or usage pricing would give rise to charges the varied only upon the basis of the volume of data transmitted. To a large degree flat unit pricing is the basis upon which conventional telecommunications interconnection charges are calculated. While per-minute charges now commonly varying according to two broad categories, peak and off-peak, the total revenue from per minute charges is calculated on the basis of recovering the costs of the network plus a reasonable rate of return.

Variable unit or usage pricing dependent upon the network costs imposed could be described as 'congestion pricing' as the charges would vary depending upon the capacity available at the time of transmission. In congested networks variable unit pricing would result in transmission charges that related directly to the costs imposed upon the network (and other users) of congestion.

Pure congestion pricing would involve the auctioning of capacity at short intervals of time. Competitive auctioning would ensure that those users who placed the highest value on use during congested periods obtained access. Theoretically, auctioning of scarce capacity would give the appropriate economic signals to network investors.

While the idea of auctioning scarce transmission capacity may seem far fetched, and far removed from the current regulatory approach to interconnection pricing many economists believe that the emergence of spot markets at a wholesale level is inevitable as congestion problems grow. Because of the need of service providers to guarantee access to their customers, and the likely volatility of spot markets in congested infrastructure industries the emergence of spot markets would in turn give rise to futures or secondary markets in which resellers and wholesalers could hedge their risks. Again this may seem fanciful in 1996 but the rapid development of spot and secondary markets in the deregulated electricity and gas industries in the UK, US and Australia provide a precedent.

However the key difficulty with congestion based pricing is that the recipient of the pricing revenue has an incentive to cause congestion in order to collect more revenue. Congestion can be caused by: withholding capacity; by strategically not building capacity or by hiding capacity.[11]

The idea of transaction-based pricing raises fear and loathing in the Internet community because it involves charging for transmission or carriage services on the basis of the content of the message. However, the Internet community conveniently forgets that it has had, and continues to have, a free ride on the backs of the telcos which have incurred considerable capital risk in the deployment of the telecommunications network that provides the backbone of the Internet. Politically and economically this free ride has been tolerated by both the telcos and the regulators because it has involved, to date, the use of networks often deployed by regulated (and in many cases government owned) monopolists. Further, the costs of the local loop are generally both sunk costs and often recovered costs. That is, the networks have been largely paid for.

However, the explosion of the Internet is quickly creating massive congestion problems for the telcos. Ubiquitous access to the Internet will require significant upgrades to the local loop and the switches supporting it. This will require investments by the telcos of billions of dollars.

The telcos are unlikely to invest in the necessary upgrades, if the ISPs are to gain access to that infrastructure at the sorts of rates they are currently enjoying. For the telcos the level of investment necessary will be prohibitive if they are relegated to the role of regulated wholesalers of transmission capacity. Given the current regulatory frameworks the scenario for the telcos is massive infrastructure investment and capital risk selling wholesale capacity to ISPs, who bear little if any capital risk. These ISPs then engage in complex arbitrage involving the use of bulk capacity to supply content services to end-users (for which they pay to the ISP) something close to the economic value of the service. In short the ISPs make windfall gains with little if any risk.

> *"Competition in an undifferentiated commodity at the lower level will not be feasible. The long term result might be a gradual disinvestment in networks, the reestablishment of monopoly, or price cartels and oligopolistic pricing. Thus policies promoting competition in the*

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> *provision of unbundled bearer services among owners of physical networks may ultimately fail."*[12]

9. THE REGULATORY DILEMMA

There are unique challenges to regulating Internet telephony. The ACTA's proposal to ban the sale of the software us unrealistic, if only because, it is currently possible to download the software from the Internet.

The UK regulator, OFTEL, has decided to take a "wait and see" approach, because "it will take a while to see how - or if - these particular services impact on current regulations. The FCC Chairman is more inclined to take a "hands-off" approach and allow market forces to work out a solution:

> *"I am strongly inclined to believe that the right answer at this time is not to place restrictions on software providers, or to subject Internet telephony to the same rules that apply to conventional circuit-switched voice carriers. Instead we should be trying to fix the old rules so that if those new technologies really are better, they will flourish in the marketplace. Internet telephony may well become, in time, a competitive alternative to traditional circuit-switched voice telephony. But I'm inclined to believe our best guidance is to let technology, competition, and access reform make the problem go away.."*[13]

Usage based pricing may require regulation of content of traffic on the Internet. While it may be technically feasible (although extremely costly) to determine which data packets on the Internet are messages sent by email, which packets constitute a message in a sound file, and which are the messages sent by Internet telephony it would require monitoring of all data conveyed on the network.

Conflict between interests of investors in networks to recover costs and a reasonable return - metered network usage would mean that the transmission charges for content requiring higher bandwidth, such as sound and video, may adversely impact upon the incentives to develop enhanced applications.

> *"Given that the marginal costs of sending an additional packet of information over the network is virtually zero once the transmission and switching infrastructure are in place, marginal cost pricing in its simplistic form is inapplicable. Cost-based return on investment (ROI) pricing is both not feasible, given the multiplicity of providers who would have to chip in to bring about an end-to-end service, and inefficient, given the chronic problems of allocating joint costs. A what the market can bear policy would have unforeseen implications, especially if the markets are not competitive in each and every segment of the market."*[14]

10.THE SMART MARKET - A REGULATORY SOLUTION?

Economic analysis and regulatory experience from network industries suggests that the optimal approach to pricing Internet access through the PSTN would be usage transaction based pricing.

Usage based pricing ensures that end-users pay prices which reflect the costs incurred. If we only had to deal with the comparatively simple dilemma of competing Internet and PSTN telephony services usage based pricing would give rise to regulatory and competitive neutrality between the substitutable services. However, the growth of bandwidth intensive applications, such as Internet video conferencing, creates an additional dilemma. Not only are these the applications that will create the greatest congestion problems but these are also the applications with the highest value to end-users. Transaction based pricing, that is pricing transmission according to the value of the content, would ensure that those end-users who place the greatest value on the communication pay prices which reflect the congestion value imposed on the networks and other end-users. However, this optimal approach to pricing requires a 'smart market'. That is, one which differentiates transmissions both by volume and content.

Obviously, the technology necessary to implement a 'smart market' is not yet commercially available. In the meantime we are starting to see evolutionary steps in this direction. For example, MCI has recently announced that it will institute measured usage pricing on T-1 connections to its backbone.[15]

While the abandonment of flat rate pricing for ISP's will generate heated debate and commercial pain the signs are clear that the free lunch will soon be over. The regulatory challenge will be to create communications regulatory structures which simultaneously: preserve an environment in which Internet applications, including telephony, can continue to develop; ensure revenue streams to the telco's adequate to give the necessary incentives to upgrade and expand the infrastructure underlying both the Internet and traditional telecommunications services; and ensure regulatory and competitive neutrality between substitutable services.

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Internet Services in Asia: The Rapid Emergence of Competition and Regulations

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The liberalization wave and booming infrastructure development of the telecom sector in developing nations is fueling the competitiveness among Internet service providers in Asia. Due to the varied regulatory environments, the evolution of the Internet services market has followed different courses in each country. In Hong Kong, the high-profile temporary shutdown of seven of the eight Internet service providers in March 1995 heightened the awareness of the Internet, and actually accelerated the entry of an additional 32 Internet service providers by year-end 1995. In contrast, Internet services in Singapore has served as the testbed for the island's first real exposure to telecom services competition. In September 1995, Singapore licensed its second and third Internet providers - Pacific Internet and Cyberway - a full year after Singapore Telecom's subsidiary, SingNet, launched its Internet services. This paper will examine the influence of differing regulatory environments on the development of the Internet services market, including the regulation and classification of Internet services, and the licensing of Internet service providers.

The customer base of Internet services is shifting dramatically from academics to individuals, entrepreneurs, and businesses. Attracted by the diverse and exploding customer base of Internet services, major public network service providers in Asia see Internet services as an essential component in establishing themselves as a full-service telecommunications company. In its efforts to become a full service telecom provider, Globe Telecom became the first telecom carrier in the Philippines to offer Internet services with the launch of its G-net in May 1995. The aggressive strategies by Internet service providers to attract and maintain customers has also launched price wars in Asia. In addition to the exploration of the regulatory issues, this paper will also focus on the evolution strategies of Internet service providers in Asia. Specific country examples will be discussed, with a focus on the market environment in each country, the differing strategies being implemented, and the effects of competition on customers.

Similar issues throughout Asia have affected the evolution of Internet regulatory environment in each country differently. These issues have included methods of control and regulation, especially of pornographic and "subversive" material. Overall, though, the issues appear to stem from the political mindset of the government. In China, Singapore, and Vietnam, the government leans toward a more socialistic approach. In Hong Kong, Korea, Taiwan, and the Philippines, the government views Internet services as an arena where open competition is beneficial.

Strict Regulation of the Internet - Singapore, China, Vietnam

In traditional socialist countries, concerns over the regulation and control of information and Internet services have served as a strong hindrance to the development of Internet services and access. In Singapore, the number of Internet service providers have been restricted to three - Pacific Internet, SingNet and CyberWay - to maintain control over the providers and its subscribers. The Singapore Broadcasting Authority, the government agency responsible for Internet content regulation, will institute strict censorship laws for Internet access as of September 15, 1996. All subscribers to any of Singapore's three Internet service providers will be denied access to web sites that the government has deemed inappropriate. The Singapore government has required all the Internet service providers to pass each request to access a specific site on the Internet by their subscribers through proxy servers. The proxy servers instantly compare the request with a list of prohibited sites. The extent of prohibited sites range from pornography to religious to political sites. Singapore has termed this regulation, the "anti-pollution measure in cyberspace."

Singapore's strict regulation stance emerged quickly after the announcement of China's newest regulatory legislation, which was signed into law on February 1, 1996. While China has licensed over 20 Internet service providers and authorized at least six international Internet links, the new law is one of the most restrictive set of Internet regulations that appear in Asia. All subscribers who access any international networks such as the Internet must register with public security departments within 30 days. In addition, all international computer networks are required to operate through channels established by the Ministry of Posts and Telecommunications, the regulatory authority of Internet services. The rationale behind the legislation is based on China's concerns to protect state security and to minimize obscene, subversive, and pornographic materials. The law allows the Chinese government to filter all international Internet traffic entering and leaving the country to screen for any network activities such as the production, duplication, or transmission of information that will harm the state or hinder public order.

Vietnam's Internet environment is still in its infancy stages. Even so, Vietnam, whose development process has often been compared to that of China's, is considering establishing a regulatory environment similar to that of China, where installation of computer software will allow the government to filter out pornographic and unacceptable material. While Vietnam has not implemented any laws to restrict Internet access, its concerns over the lack of control of Internet access has resulted in debates over who will regulate the services and delayed the launch of Vietnam's first direct Internet connection. The Directorate General Posts and Telecommunications (DGPT) will most probably be the authority responsible for Internet regulation, especially since it established the selection process for Internet service providers. In June 1996, the DGPT created a temporary regulation allowing Vietnamese companies to apply for licenses to serve as Internet service providers. This regulation authorizes legal, direct access to the Internet on a trial basis. At the moment, the Internet can only be accessed through file servers in Vietnam, which have Internet accounts abroad. Political infighting over ownership of political authority have delayed a full launch of Internet services with direct access from Vietnam. The Vietnamese government installed the infrastructure for a 32-channel gateway to the Internet, with plans for a December 1995 launch. The Vietnamese contracted with Sprint to provide a variety of Internet services as well as special security software that would detect certain users. Citing technical and administrative problems, Vietnam delayed the launch.

More Liberal Approaches Benefit Consumers and Services

Even though the depth of control and regulation required is constantly debated in more democratic countries, Internet services have mainly benefited and not been hindered by these debates. The highly publicized debates and regulatory actions in countries such as Hong Kong have increased awareness of Internet services as well as publicized the access providers. In Hong Kong, the Office of Telecommunications Authority (OFTA), which is responsible for Internet regulation, had been slow to regulate and monitor Internet service providers. In late 1995, OFTA took strong measures to ensure the registration of Internet access providers and to strengthen its regulatory authority over the market, in the name of customer protection. The highly publicized shutdown of unlicensed providers in March 1995 publicized the availability of Internet access providers and their services.

Similar to Hong Kong, other countries - including Korea, Taiwan, and the Philippines - have liberalized its licensing process for Internet service providers. Hong Kong with its 40 Internet access providers, including both academic and commercial networks, has created a highly competitive market, which has benefited consumers as well as other industries. The paging market in Hong Kong was revived with the innovative creation of linking e-mail and paging, so that whenever a customer receives a new e-mail message, notification appears on the pager. Korea and Taiwan have also developed numerous services working off the Internet, such as databases, information services, etc. . The high level of competition created in these markets have benefited consumers through lower prices and higher quality of services.

The emergence of competition throughout Asia's Internet market has stimulated debates over regulation. Regulators, who have neglected their Internet responsibilities, are struggling to get up to speed with the market trends and concerns. Regulators, who are tightening their control of the market, are benefiting from the new technologies, employing various control mechanisms. As the awareness of the Internet and its diverse services accelerate throughout Asia, regulators will continue to struggle as Internet service providers discover new services challenging the authority and scope of the regulatory bodies.

THE NTT DIVESTITURE DEBATE - A BATTLE OF THE FUTURE INFORMATION SOCIETY

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Abstract

This paper discusses reasons why the NTT divestiture debate has occurred several times despite its high political costs, and why MPT has faced so heavy opposition, so far.

1. Introduction

The question of a divestiture of NTT has been alive and well in Japanese telecommunications policy debate for more than 15 years. The Ministry of Posts and Telecommunications (MPT) has been heavily engaged in the debate all along, but it has suffered several serious blows and defeats. Most visibly, the MPT position has been revealed in three instances. The first time that MPT had a stance toward a divestiture emerged in the early 1980s as part of the preparations for the NTT privatization, when MPT and the Second Provisional Committee for Administrative Reform interacted. However, the final outcome of the privatization preparations in this regard was that the NTT status be reviewed in 1990, NTT being kept as a single unity for the sake of a successful privatization. Again, the MPT push for a divestiture in the formal NTT Review processes in fiscal years 1990 and 1995 both ending with the ruling that a final decision be further postponed. In all of the decisions reached, the NTT divestiture became a greatly politicized issue, with high personal and organizational stakes involved.

The recurrence of the NTT divestiture debate despite its risky nature for MPT naturally raises several questions. In particular, this paper will address two of them:

1. Why has MPT been unsuccessful in the NTT divestiture debates?
2. What are the roots of MPT's persistence, despite the political risks?

Obviously, any attempt to answer these questions cannot be exhaustive or true in an absolute sense of the word due to the quite complex nature of the issue at hand. Instead, this paper will aim only to offer a perspective. The argument of the paper can be summarized as follows. The deep changes in technology in the information and communications field, specifically digitization, create new technological opportunities. In turn, the technological opportunities offer new organizational opportunities in terms of strategy and policy with possibly very wide-ranging impacts on society. However, the new organizational opportunities may lead to conflicts of interest among interacting parties due to changes in the objective functions of the respective parties. In the case at hand, convergence of computing and communications affects the range of influence for MPT (or any regulator/policy

-maker in the field of telecommunications) as well as for NTT (or any incumbent telecommunications operator). The battle of the NTT divestiture can be seen as a battle over the future information society.

The paper tries to make this connection explicit in the following way. First, the three rounds of the divestiture debate will be briefly analyzed in terms of actors and interest groups. Second, the roots of the conflicts will be traced to earlier times, dealing with the changing roles and emerging conflicts over the future information society. A concluding section will bring the pieces together.

2. The divestiture debates: An overview of main actors and positions taken

The findings in this section and the following are based both on literature and an interview series carried out in 1994 and 1996.

This section will provide a perspective on possible reasons why MPT has been unsuccessful in its attempt to divest NTT - its weak power position.

The divestiture question has surfaced three times as a part of formal debates and reviews. First, in the period of 1981-1983 in connection with the studies on NTT privatization by the Second Provisional Committee for Administrative Reform the question was intensely discussed, the resolution being that the divestiture decision should be postponed for five years, and then reconsidered. As the new telecommunications legislation came into effect in 1985, this meant that the next NTT review was set for 1990. When the divestiture question was reviewed in 1990 the final conclusion was a postponement for yet another five years. Again, in fiscal year 1995, ending March 31, 1996, the decision was postponed until the next ordinary Diet season, to end in March 1997 after the new election.

In all the three debates, there has been a complex interaction among policy-setting bodies and entities that have a stake in the debate. The complexity of interaction is exacerbated by the fact that much discussion is hidden from the public scene, and also by the fact that there is sometimes a wide divergence between what is the unofficial but actual position taken, versus the official position stated. However, over the course of the three instances, the positions have been quite stable, heavily influenced by the main interest groups served by each entity. To put the pieces together, Figure 1 delineates the most active bodies in the three discussions, indicating the various conflicts of interest and where there have been congruent interests. Clearly the figure represents a simplification and an interpretation, attempting to bring out the dominant features of the respective groups.

Both the stability of the positions taken and the type of actors involved serve to explain why MPT has been unsuccessful so far - see Figure 1. First, what stands out in Figure 1 is the relatively lonely and precarious position of MPT, having rather limited support from other main actors in the debate, basically only from politicians and the NCCs. Although limited, the support that MPT has obtained has been critical for its activities, primarily its political support. (The support from NCCs is closely related to MPT's own actions, for instance through MPT's administrative guidance in the competition against NTT, and through the process of *amakudari* whereby ex-bureaucrats obtain high offices among NCCs, most notably in the case of DDI.) The political power of MPT has traditionally resided in its influence

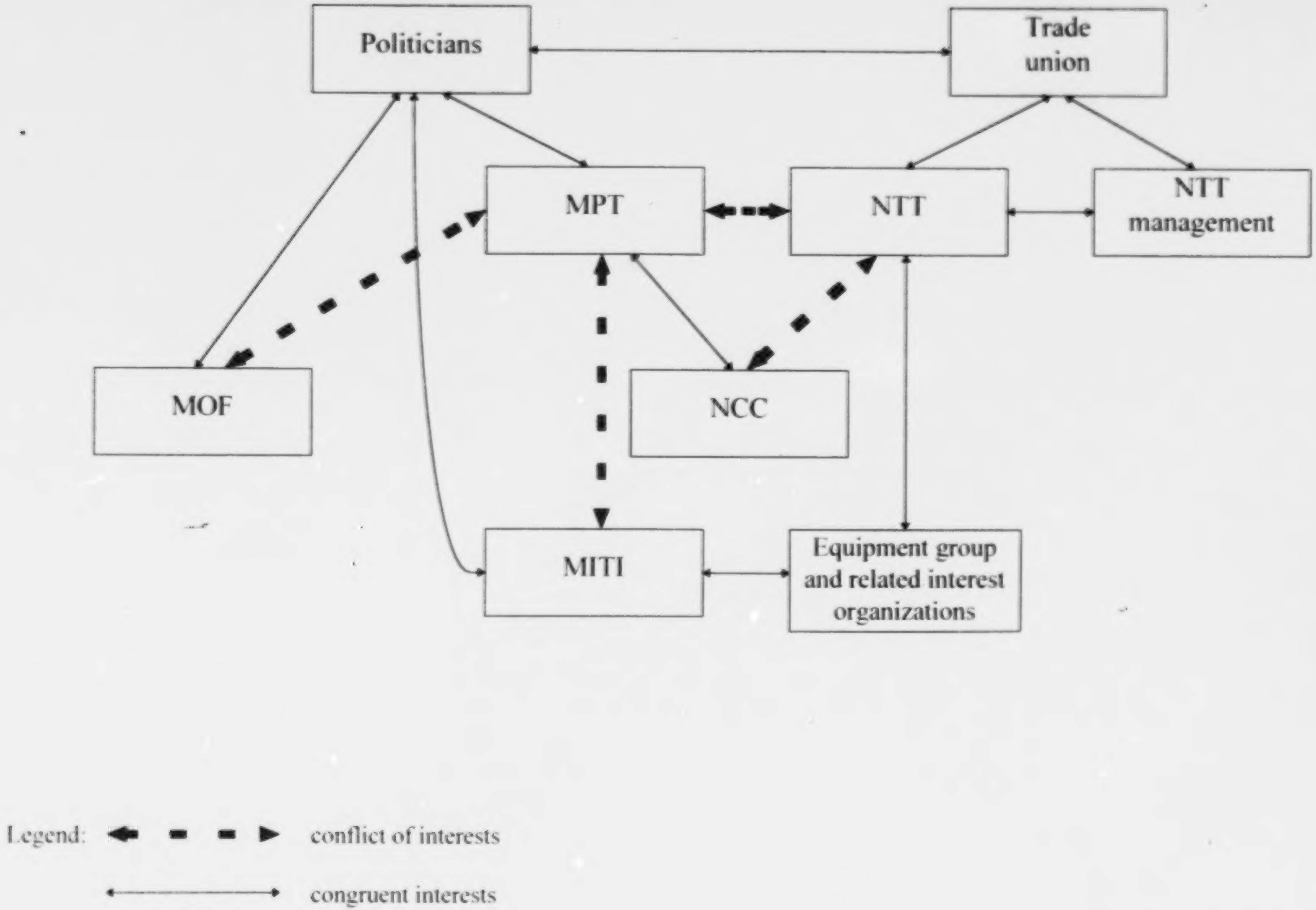
Politicians
Trade union
MPT
NTT
NTT management
MOF
NCC
MITI
Equipment group and related interest organizations
Legend:
conflict of interests
congruent interests

Figure.1 Conflicts and shared interests in the NTT divestiture debate among the main actors.

and relationship with the rural post-masters, heading very small post-offices. As described by Johnson (1989), the rural post-masters had an important influence over rural voters who in turn were a critical community for the electoral system in Japan, in which rural areas had in international comparisons an unusual influence over actual outcomes. Moreover, the LDP had several internal factions and within these so-called tribes or *zoku* the MPT had a strong influence over the "postal tribe" in the 1980s and early 1990s. However, with the disintegration of LDP in the 1990s, MPT's political support has become weaker, contributing to the outcome for the 1995 NTT Review.

If we then turn to NTT, several important support groups are revealed. First, the role and political influence of the NTT Trade Union can hardly be overestimated in all three of the divestiture debates. The trade union has had direct channels of contact with both the socialist party and the LDP, and these have been used in all three instances, being leveraged by the size of the union and its influence on votes, particularly in rural areas. (Similarly to the post-masters, the union man wields considerable local influence.) Second, the equipment manufacturers have been an important group of players to sustain the claim that NTT's R&D should be considered a national asset. As Fransman (1995) has extensively argued, the equipment companies associated with NTT have had a special role of controlled competition vis-à-vis the Japanese telecommunications operator, and have benefitted from NTT's R&D. The equipment companies have in turn a strong relationship with MITI.

MPT has had quite generic conflicts with two important ministries, the Ministry of Finance (MOF) and MITI, making them reluctant to support the MPT divestiture proposals, regardless of their own particular agenda. MOF and MPT have had a long-standing strained relationship due to conflicts over postal savings, the latter being part of MPT influence. Between MITI and MPT, the convergence of information and communications technologies has posed particular challenges, since convergence cuts across their respective jurisdictional boundaries.

Aside from the generic conflicts, the overriding concern of MOF related to the divestiture has been the impact on the price of the NTT shares, since MOF administers the future sales of the two-thirds of NTT shares that remain with the Japanese government. Here, the dominant perception has been that a divested NTT may adversely impact share price. For MITI, its primary interest has been to strengthen the equipment companies, and to the extent that a divestiture will have negative effects on the equipment companies, MITI has had a negative opinion.

Other groups have entered the debates as well, although their role is not as clear-cut. For instance, Keidanren is one of the most powerful lobbying organizations in Japan on behalf of large companies. An influential member of Keidanren is NTT, but companies associated with the NCCs have also had influence (for instance, Teleway Japan is partly owned by Toyota and DDI is partly owned by Kyocera). Keidanren's primary effort has been to strengthen the liberalization process in Japanese telecommunications, but in so doing there has been an implicit criticism of how MPT has handled its role. However, in official statements Keidanren has taken an ambiguous position on the divestiture.

Another group is the Fair Trade Commission (FTC). In all three divestiture debates, FTC has been involved and giving opinions from the perspective of anti-trust. Although anti-trust concerns would lead one to suspect a stance favorable toward divestiture, FTC has if anything supported keeping NTT intact. This may seem surprising but FTC has had a long-standing aim in Japanese policy-setting to support large companies, being indirectly linked with MITI's policies to promote high-speed growth. A third group that has taken a more ambiguous view in relation to the divestiture is the U.S. Government. Clearly, the U.S. Government was active in dealing with MITI when MITI had conflicts with MPT over the issue of value-added networks in the beginning of the 1980s. The activity was such that some writers considered the U.S. Government to be an additional force in domestic policy- setting in Japan (e.g. Gow, 1989 and Muramatsu, 1989). One would perhaps then expect U.S. activity on the divestiture issue, but statements have been vague. A final group that has not raised any significant voice are users. As there is no government agency in Japan that explicitly deals with consumer issues, nor is there any strong telecommunications user association in Japan, users have not had a direct role in the debates.

In summary, this section has attempted to answer the question as to why MPT has lost the debate so many times. Simply put, the MPT position has been quite weak compared with the NTT-complex. The interest groups that support MPT have not been sufficiently strong compared with opposing interest groups. Moreover, potentially critical interest groups such as Keidanren and FTC have been neutral, or even supportive toward NTT.

3. The roots of the conflicts

This section will trace the origin of the conflicts of interest to the evolution of the objectives and roles of the actors involved.

The early history of MPT is full of prestige and influence. The Ministry of Communications was established in 1885 and immediately assumed the responsibility for mail and the telegraph in Japan, and a few years later it managed telephony expansion as well. In telecommunications, it had the dual role of an operator and a regulator, operating as a national monopoly. The Ministry soon adopted a philosophy of controlled competition, visible in the case of the development of automatic switching technology, as described by Fransman (1995).[1] Moreover, the Ministry developed in the 1930s into a stronghold of nationalism, being one of the central and dominant ministries in the pre-war period (Johnson, 1989). Thus, the antecedents of MPT included both an industrial policy role and the idea of national protectionism.

However, the power locus shifted after the war. The Ministry of Communications was dissolved in 1949, as part of the ministerial reconstruction for peacetime, and two new ministries were created - the Ministry of Postal Affairs and the Ministry of Telecommunications. In 1952 the bulk of the Ministry of Telecommunications was transferred to a public corporation, NTTPC (Nippon Telegraph and Telephone Public Corporation) or NTT for short. The remainder of the Ministry of Telecommunications merged with the Ministry of Postal Affairs, forming the Ministry of Posts and Telecommunications (MPT). Not only most of the telecommunications-related personnel were transferred to NTT but also most of the competence and initiative. In fact, the MPT office of telecommunications supervision had only a few members, compared with the 162,000 that formed NTT in 1952.

Between 1952 and 1979, NTT was at center stage. During this time, the NTT mission revolved around reconstructing and expanding the telecommunications network. NTT inherited a network that had been seriously damaged by the war - between 1938 and 1943, the number of subscribers dropped to half, and in Tokyo the number of subscribers had dropped from 200,000 to 16,000.[2] Reconstruction planning was formulated in five-year plans in which goals and the necessary investments and operational measures were stated. Two main goals were delineated, lasting until 1979: (1) to eliminate the waiting list for telephone service (formulated in the 1952 five-year plan), and (2) to establish a nationwide direct-dialing system, i.e. a fully automated telecommunications network (formulated in the second five-year plan). Due to the strong and unprecedented economic growth starting in the 1950s and continuing throughout the 1970s, the waiting list peaked in 1970, totalling 2.91 million. It was only by March 1978 that the waiting list was completely eliminated, and by March 1979 the network was 100% automatic.The network expansion during this period was a remarkable achievement. For instance, between 1952 and 1978 the number of subscribers increased 26 times, from 1.4 million to 36 million. Only between 1967 and 1977, the number of subscribers increased by 24 million. In total, about 15.3 trillion yen was spent on investments between 1952 and 1979.[3, 4]

MPT, on the other hand, was in the background during this period of growth and achievement. Colloquially, MPT has been called NTT's foolish elder brother while NTT was the smart young brother, and sometimes MPT was regarded as 'NTT's Kasumigaseki Branch Office' (Johnson, 1989, p. 190). MPT had the task of approving NTT's plans - basically putting the stamp of approval upon documents filed by NTT. In essence, MPT had a mediating role between the Diet and NTT as it was the Diet who determined budgets and telephone rates. Given the particular status of NTT, being one of three public corporations controlled directly under the Diet, this lesser role is not so surprising.[5] And not only was MPT's role smaller: it had far less favorable recruitment of young staff. For the law students of Tokyo University, MPT ranked among the lowest of the ministries. By contrast, NTT ranked with the highest of the private companies for both engineers and law students of Tokyo University.[6]

Shortly after the major objectives of the first two five-year plans had been achieved, something happened within MPT. A process started whereby MPT sought to take a more independent stance toward NTT, a process which became increasingly visible during the 1980s and 1990s. The first step toward shaping this new role was the establishment of the Bureau of Telecommunications Policy within MPT in 1979, replacing the Telecommunications Inspection Bureau. A notable feature is that this reorganization involved setting up a "policy" bureau, quite different from the previous role of MPT. The change was a visible indication that MPT now desired to become a "policy" ministry, and be treated as an equal of other such ministries (e.g. MITI, MOF). Concurrently with this move, MPT initiated three major internal studies relating to the future role and ownership of customer premises equipment, tariffing and the future structure of NTT. At the same time, the Advisory Commission on Telecommunications was established, filing reports in the summer of 1981, and giving important impetus to the Second Provisional Commission of Administrative Reform, launched in 1981 as well. This group also made studies relating to NTT's future.

However, even before the explicit organizational and attitude change toward NTT, MPT had started to search for a way to influence the development of the information society. This pursuit of a new role became apparent in conflicts with MITI, which was also seeking a role in the information society, but earlier and more vigorously than MPT. Already in 1967, MITI formed an Information Industry Section, a permanent council with the task of advising MITI on informatization. A study was submitted in 1969 on "Tasks for Informatization - Report on the Development of Information and Information Processing Industries", comparing the degrees of informatization in Japan, Britain, France, United States and West Germany. As a general conclusion, several policy measures were proposed (Itoh, 1994). Moreover, in 1972 a MITI-associated think-tank, Japan Information Processing Development (JIPDEC), proposed a much publicized plan entitled "The Plan for an Information Society: Toward a New National Goal" (Itoh, 1994). The plans and policies were initially oriented toward MITI's primary constituency in information technology, i.e. the computer-manufacturing firms. However, the MITI initiatives increasingly impacted MPT's sphere of influence. For instance, MITI sponsored in the early 1970s a law proposal on "Fundamental Information and Communications Law", aimed at achieving further liberalization of data communications, which MPT had begun in a limited fashion in 1971. Moreover, MITI established a Community Information System Investigation Committee in 1971 to study the feasibility of using cable television for information services. MPT responded by setting up a similar committee some months later. A further example is the MITI Technopolis Plan, involving information technology use, versus MPT's Teletopia plans in the early 1980s. The list could go on, and the conflicts between MITI and MPT became increasingly adverse and intense, escalating in the period 1980-1985 with the so-called "VAN war" (Johnson, 1989).

NTT on the other hand was increasingly pressured when it had reached its fundamental goals - universal coverage and automation - toward the late 1970s. The pressures were caused by inefficiency, and the concerns about NTT were not unjustified. Due to the significant expansion in the 1960s and 1970s, the work-force had grown sizably, but revenue per employee and labor productivity were low in comparisons.[7] Further, NTT had been more and more challenged in the press and by critics over its monopolistic tendencies and inefficiencies. Particularly the problems in data networking were a thorn in NTT's side. The official start of NTT's data networking, with the trial service in 1968 for a nationwide inter-bank domestic exchange transaction system for local banks, was about 10 years after the Bell System had inaugurated its first data networking services.[8] Moreover, the tariffs for data communications services were not favorable in international comparisons. The public complaints about NTT escalated toward the late 1970s and early 1980s, also here contributing to the formation of the preparatory work on NTT privatization by the Ad-Hoc Committee of Administrative Reform, starting in 1981.[9] In essence, the efficiency of NTT and its resistance to change came increasingly under criticism, and this was particularly acute for the NTT

Labor Union which had as a basic objective to preserve and enhance NTT's work force.

In response to the pressures and to the advent of new technological opportunities, NTT made its future technology deployment plans more aggressive. The same year as the NTT decision to develop a digital switching family (1977), a vision for the future integrated and digital network was developed internally by the Chief Engineer, Dr Kitahara, the so-called INS (Integrated Network System). The INS concept was formally announced at the 1979 ITU Expo Meeting, and this announcement formed a publicity milestone in NTT's evolution of its technology and service vision. INS came to include diverse and differentiated services and capabilities, among these visual communications, multiple media and also non-distance-based rates. However, these applications were not entirely original and the concept in turn had several roots and preliminaries. Before the vision coalesced into INS, Dr. Kitahara spoke of telecommunications service diversification and so-called post-telephone services, including visual and data services and broadband capacities (Kitahara, 1978). Moreover, the INS concept is just a different term for ISDN which was in the preliminary stages of standardization in the international standardizations body, the CCITT, well before the time of the INS announcement.[10] The general idea of merging computers and communications was also an increasingly common industry view, pre-dating Kitahara's, e.g. with the announcement in 1977 by Dr. Kobayashi of NEC on C&C (computers and communications). Still, NTT was early internationally in stressing the concept as the central corporate vision for the future. The INS concept subsequently formed an important base for the future development of NTT's service and technology vision (cf. NTT's plans for B-ISDN, VI&P in the late 1980s and early 1990s).

To summarize, the MPT has undergone an evolution from being one of the foremost ministries before the war into becoming "NTT's inferior brother" after the war, during the time of reconstructing and expanding the basic telephone network infrastructure. However, as NTT reached the goals of getting rid of the demand back-log and achieving a fully automated network toward the end of the 1970s, new technological opportunities presented new opportunities for revised objective functions of the actors involved. In particular, digitization of the network - or using other terms, the convergence of computers and communications - provided a platform for service diversification and expansion, impacting the business mission of NTT. On the other hand, technological convergence promised to change society in fundamental ways - as the emerging information society. Influencing this emerging society became a high-priority issue for both MPT and MITI in the 1970s, with resulting conflicts between the two ministries. Increasingly, MPT's attention shifted toward NTT instead in the 1980s. NTT's emerging technology and service vision in the late seventies pointed towards the realization of a future network in which computers and communications could coexist. In turn, realization of such a network promised to be one of the key components of the future information society. Influencing this area of the economy will clearly be of central importance for the future. To the extent that MPT wanted to be a policy ministry within its jurisdiction, managing NTT became an increasingly critical activity.

4. Conclusions

The NTT divestiture debate displays a series of intense conflicts and collision of interests. The recurrence of the issue, despite its political costs and risks, presents us with several questions, inviting our speculation and interpretations. In particular, it does not seem reasonable to ascribe the conflicts solely to a quest for power for its own sake; these are power struggles in order to achieve something valuable. In other words, what are the fundamental resources which the debate has concerned itself with?

Admittedly, the debate confronts us with many interrelated and highly political and issues and interests, but the perspective suggested here is that the NTT divestiture belongs to a battle over the future information society. The changes in technology in the information and communications field create new technological opportunities which in turn offer new organizational opportunities in terms of strategy and policy. However, the latter may lead to conflicts of interest among parties due to changes in their objective functions. In the case at hand, NTT's service and technology vision from the 1950s to the late 1970s was dominated by the expansion of the basic telephony network. As this goal was fulfilled, a search for a new mission ensued which coalesced in the INS concept - integrated communications. MPT was NTT's "inferior brother" during NTT's time of expansion, but started to "grow in posture" as the basic telephony goals were reached. MPT increasingly positioned itself as a policy ministry, and came into several heated conflicts with MITI, particularly concerning data networking. In the 1980s and 1990s, the main points of conflict concerned NTT, in particular the divestiture issue. NTT's response strategy included the involvement of strong political actors, such as the equipment companies and the labor union. However, the response also involved renewing NTT's technology and service vision. In 1981, NTT announced a massive investment plan for its future INS network, timed to reduce pressure from the divestiture proposals brought up in the privatization preparations. Again, when the divestiture pressure mounted on NTT in the fall of 1989 and spring of 1990, NTT brought forward very aggressive investment plans in B-ISDN (later renamed as VI&P). Finally, in the fall of 1995, NTT launched the OCN concept, involving investments in a new open network architecture, again in response to the escalating divestiture pressures. MPT, though, has increasingly positioned itself as the vanguard of the information society through its more recent emphasis on NII and GII. Technological opportunities are resources not only for growth but also for influence.

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[1] Basically, the idea of controlled competition is that of a co-operative relationship between a large procurer and user of equipment and a closed group of suppliers which compete in outside markets (Fransman, 1995, p. 22).

[2] Kitahara (1976, p. 193), Johnson (1989, p. 189).

[3] Kitahara (1980, p. 4). Compare with Nambu et al. (1989, p. 156) who present an estimate of investment spending of 11 trillion yen in 1968-1977, and 12 trillion yen in 1978-1984.

[4] An important instrument for financing this expansion was the NTT bond. The principle behind the bond system was that the bond price approximately equalled the average cost of installing a telephone (Oniki, 1994). After March 1982, no more bonds were issued.

[5] There were many public corporations under the jurisdiction of ministries, but only three directly under the Diet: NTT, Japan Railways and Japan Tobacco Corporation.

[6] Graduates from Tokyo University (Todai) have a special rank among university students in Japan, ever since the Imperial Ordinance issued in 1886 stating that Todai has a specific duty to train public administrators.

[7] Johnson (1989, p. 216) claims that government auditors concluded that NTT had at least 100,000 surplus workers.

[8] Takahashi (1981) elaborates on critical dates in NTT's early data communications. AT&T Bell Laboratories (1985, p. 739) describes the first commercial data communications service of the Bell System, established in 1958.

[9] Just as the Ad-Hoc Committee of Administrative Reform started to look into the issue of NTT reform, Professor Imai and the Forum of Policy Innovation released a publication that was severely critical of NTT and the functioning of the Japanese telecommunications market (see Imai 1982, originally published in Japanese in 1980). This publication received quite a bit of attention in the press, as the NTT president Akikusa faced a scandal, involving perks to NTT employees and was forced to resign.

[10] For instance, Chapuis and Joel (1990) show how documents in the Bell Laboratories envisaged the merging of computers and communications in telecommunications networks already in the 1950s.

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Impact of the Telecommunications Act of 1996
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ABSTRACT

The telecommunications needs of the United States insular areas located in the Pacific (i.e., the Commonwealth of the Northern Mariana Islands, Guam and American Samoa) have traditionally been overlooked by the U.S. federal government. The consequences of this regulatory inattention have been high, unaffordable telecommunications rates, low subscribership, poor integration with the U.S. mainland, and lost economic opportunities. The Telecommunications Act of 1996 specifically seeks to resolve these problems by including the U.S. insular areas within the national systems of rate integration and universal service support. The insular areas also stand to gain from the 1996 Act's pro-competitive provisions, intended to open and deregulate the U.S. telecommunications market. Together with the insular areas' inclusion in the North American Numbering Plan, these policies will do much to make affordable, higher quality telecommunications services available to the citizens of U.S. insular areas, and should serve as a positive example of regulatory reform for other nations of the Pacific Rim.

1. INTRODUCTION

The three U.S. insular areas located in the Pacific are the Commonwealth of the Northern Mariana Islands ("CNMI"), the Territory of Guam ("Guam") and the Territory of American Samoa ("American Samoa"). Although the residents of the insular areas are U.S. citizens, their interests have long been overlooked or ignored by federal policy-makers in Washington, to ill-effect. The failure of the federal government to include the Pacific insular areas in national programs such as rate integration or effectively address the insular areas' needs as geographically remote U.S. points has caused the insular areas to be isolated by high telecommunications rates.

The Federal Communications Commission ("FCC") has rarely applied federal telecommunications policies to the CNMI or American Samoa and only recognized the applicability of the Communications Act to Guam as late as 1992.[1] Even though the FCC expressly ruled that Guam was in fact a domestic point,[2] the FCC has treated the insular areas as international points and their telecommunications traffic was routed and tariffed as international traffic. As "international points," the insular areas were not included in the North American Numbering Plan, forcing callers in the insular areas to use inconvenient international country codes and dialing protocols when calling to the mainland U.S. Moreover, in an omission which contributed significantly to high telecommunications rates, the insular areas were the only U.S. points that the FCC did not include in its rate integration mechanism.

Some regulatory treatment of the insular areas has been downright inconsistent. For example, despite its historical status as an international point, the FCC has allowed the telephone company serving the CNMI, Micronesian Telecommunications Corporation ("MTC"), to extend the domestic access charge plan to CNMI subscribers. Consequently, not only have CNMI ratepayers been called upon to pay high international rates, they have also been subject to domestic subscriber line charges.[3]

As a result of international ratemaking, international call routing, and high distance-related costs, consumers in the insular areas have long paid telecommunications prices that were several times higher than mainland rates.[4] Such high rates have served to depress subscribership and discourage the widespread use of telecommunications. Moreover, the fact that the insular areas could only be reached via international calls -- resulting in the insular areas' exclusion from telephone books in the continental U.S. -- served to lower their profile and hamper their social and economic ties with the mainland and the rest of the world.

Although it is difficult to quantify the lost investment opportunities, lost tourism revenues, and exacerbated economic problems that result from such isolation, the statistics documenting the economic underdevelopment of the insular areas are telling. To use the CNMI as an example, the average per capita income in the CNMI was only $6,984 in 1995, ranking it 53rd among the 54 U.S. states and insular areas.[5] Approximately 32.1 percent of all families in the CNMI lived under the U.S. poverty level in 1995, and the unemployment rate was 7.1 percent.[6]

The illogical and inconsistent treatment of the insular areas has hopefully ended with the Telecommunications Act of 1996 ("1996 Act"), enacted on February 8, 1996. The 1996 Act specifically states that "insular areas" are to be included within the sweep of the nation's telecommunications policies.[7] This requirement and the implementing regulations which resulted were the product of intense lobbying efforts by the governments of the CNMI and Guam before Congress, the Department of the Interior, and the FCC. As a result, the FCC must treat the insular areas as domestic points and extend to their citizens the benefits of uniform, integrated U.S. telecommunications policies and support mechanisms.

2. EFFECT OF THE TELECOMMUNICATIONS ACT OF 1996

The 1996 Act will have a profound effect on the insular areas and may have a potential secondary effect on the Pacific Rim as a whole. The incorporation of the insular areas in the national systems of rate integration, universal service support, and deregulated, competitive markets is a significant victory for Pacific insular area consumers. It is expected the 1996 Act will produce improved economic growth, higher quality and lower cost telecommunications services, greater competition between carriers and heightened investment in the telecommunications infrastructure in the region. Instead of being a regulatory backwater, it is possible that the insular areas will instead demonstrate the benefits of competitive, open telecommunications markets for other nations of the Pacific Rim. U.S. telecommunications policy has consistently influenced the policies of other nations in the past,[8] and if the policies adopted in the 1996 Act help solve the insular areas' underdevelopment, the statute could serve as a powerful model for the region.

2.1 Inclusion in U.S. Domestic Rate Integration

Section 254(g) of the 1996 Act codifies the longstanding FCC policy of rate integration and, in doing so, specifically extends this policy to the insular areas.[9] Section 254(g) provides that within six months of enactment, "the [FCC] will adopt rules to require that the rates charged by providers of interexchange telecommunications services to subscribers in rural and high cost areas shall be no higher than the rates charged to subscribers in urban areas," adding that carriers will be required to integrate their rates across every "state" that they serve.[10] Since the Communications Act of 1934 ("1934 Act") -- which the 1996 Act amends -- specifically provides that the "states" include the U.S. insular areas and possessions[11] and since the FCC has specifically stated that the U.S. Pacific insular areas are encompassed in rate integration,[12] it is therefore clear that the 1996 Act requires rate integration of the insular areas.

Rate integration operates by requiring interexchange carriers ("IXCs") to average the high cost of serving particular areas over a wide ratebase, so that the IXCs charge comparable rates for services at all points within their service area.[13] The primary benefit of spreading such expenses is that the interexchange rates for rural and high cost areas do not reflect the disproportionate costs of serving such areas.[14] Since the insular areas' physical remoteness from the mainland has been a large factor in producing their high telecommunications rates, Section 254(g) is likely to prove a crucial step in easing the insular areas' geographic isolation. Furthermore, the FCC's rules implementing rate integration require that IXCs offer competitive pricing packages throughout their entire service area rather than in select competitive areas.[15] This rule will likely bring insular areas benefits such as contract tariffs, Tariff 12 offerings, and optional calling plans, further reducing the rates on calls placed to the rest of the U.S.[16]

Rate integration will not be implemented immediately in the insular areas. Per the suggestion of the Guam/Northern Marianas Working Group on Rate Integration,[17] the integration of the CNMI and Guam into the domestic rate pattern will be deferred until August 1, 1997, subsequent to the date that both points will have been admitted to the North American Numbering Plan ("NANP"), discussed infra. This delay is justified by the fact that once the CNMI and Guam have entered the NANP, the IXCs will begin using standard domestic ratemaking methodologies in their tariffs instead international standards.[18] Additionally, even though America Samoa apparently did not seek this benefit, the FCC has ruled that American Samoa will also be included in rate integration effective August 1, 1997.[19]

It should be noted, however, that some IXCs are formally opposing the FCC's rules implementing rate integration. For example, IT&E Overseas, Inc. ("IT&E"), an IXC that only serves the CNMI and Guam, has requested that the FCC reconsider its requirement that all IXCs participate in rate integration, arguing that it would be competitively disadvantaged by having a comparatively small, regional, non-mainland ratebase over which to spread costs.[20] U S West and GTE Service Corporation (which owns MTC) have requested that the FCC reconsider its requirement that corporate parent companies integrate their rates with their affiliates operating in insular areas.[21] Moreover, AT&T Corp. has filed two requests seeking authority to file geographically specific promotional discounts that last more than 90 days, a practice the FCC barred in its decision adopting implementing rules since it could be used to provide discounts from integrated rates to urban customers.[22] The FCC has not yet ruled on these oppositions and requests, and regardless of the FCC's decision, the IXCs may well attack the FCC rules in court.

2.2 Universal Service Support

Closely tied to rate integration are the policies of universal service support mandated by Section 254 of the 1996 Act.[23] As defined by the 1996 Act, "universal service" is "an evolving level of telecommunications services that the Commission shall establish" and, in turn, subsidize to qualified low-income consumers or high-cost regions in order to promote subscribership and reduce inequalities in affordability.[24] Section 254 substantially expands the existing universal service program by requiring the FCC to promote quality service at just, reasonable, and affordable rates in all regions of the nation; to promote access to advanced services; and to promote affordable access in rural, insular, and high-cost areas.[25] In addition to these broad, nationwide mandates Section 254 also specifies that the FCC must provide universal service support to schools, libraries and health care providers in order to make "advanced telecommunications services" accessible.[26]

As required by Section 254(a), the FCC has established a "Federal-State Joint Board on Universal Service" (hereafter "Joint Board") to study the means by which to meet these broad mandates as well as to recommend the new rules under which the existing support mechanisms should operate.[27] Per the mandates discussed above, the Joint Board's recently released, 400-page Recommended Decision advocates expanding the federal universal service programs to the specific benefit of high cost, insular areas.[28] These recommendations will almost certainly be adopted by the FCC.

In its Recommended Decision, the Joint Board concludes that Section 254 requires that rural, insular and high cost areas must receive universal service subsidies for a wide variety of basic services including voice grade access to the public switched network; dual-tone multi-frequency (DTMF) signaling or its equivalent; single-party service; access to operator services; access to emergency services such as 911 dialing; and access to directory assistance.[29] The Joint Board has recommended that, together with residential consumers, single line businesses should also be eligible for universal service support for these services -- an important decision which would encourage entrepreneurship in insular areas even if provided at a rate less than that for domestic lines.[30]

Another important issue for the insular areas is availability of universal service support for schools, libraries and health care providers. According to the Joint Board's recommendations, schools are to receive a 20% to 90% discount on all telecommunications according to a need-based sliding scale.[31] The Joint Board has recommended that the universal service program should support discounted Internet services for eligible schools and libraries located in high-cost areas such as the insular areas,[32] as well as support for the costs of wiring classrooms.[33] While the Joint Board has suggested that the FCC seek further comment before deciding which services to support for health care providers, it is clear that support will similarly be provided for Internet access and infrastructure development.[34]

Universal service support is crucial to ensuring that rates in the insular areas are affordable. To use the CNMI as an example, the CNMI's telephone penetration rate of only 61.2 percent is among the worst in the country and is clear evidence of the unaffordability of basic services for many residents.[35] The relatively low penetration rates in the insular areas are also a reminder that many of the islands's residents currently lack access to services necessary for education, public health, and public safety systems.[36]

The 1996 Act's discounts for schools, libraries

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and health care providers will also serve an extremely important function in a period of tight resources and expanding demand for telecommunications. In the CNMI schools, the prohibitive costs for telecommunications, let alone Internet use, already hinders the use of telecommunications services by students, school administrators, and libraries at the same time demand for such services is growing.[37] In addition, during the last five years, the enrollment in the CNMI's 25 schools has risen by 20%.[38] Without universal service support, this collision of demand and affordability would otherwise lead to the isolation of the CNMI's students from the technological mainstream.[39]

There is a national strategic interest in maintaining affordable basic service in the U.S. insular areas located in the Pacific. Insular areas such as the CNMI are the closest U.S. points to Eastern Asia, and universal service (together with rate integration) will provide the citizens of the insular areas with the tools they need in order to compete effectively in the global marketplace.

2.3 The Creation of Open and Competitive Markets

In addition to mandating rate integration and universal service support for the Pacific insular areas, the 1996 Act takes numerous steps to both deregulate local telecommunications markets and establish ground rules for open, fair competition between carriers in all markets. If implemented and enforced by both federal and insular governments, provisions such as Sections 251, 252 and 253 of the 1996 Act promise to significantly increase the competitiveness of the insular areas' telecommunications markets, to the ultimate benefit of consumers.

One the 1996 Act's general purposes is to remove traditional boundaries between local and long-distance services, fully opening both markets to competition and setting the ground rules by which carriers may compete. Of these provisions, Sections 251 and 252 are the most important since they govern the ability of carriers to have full and fair access to the local networks of incumbent LECs.

Although the provisions of Sections 251 and 252 and the FCC's implementing regulations are complicated, a brief review of their requirements is necessary. Section 251(a) imposes a general duty to interconnect directly or indirectly between all telecommunications carriers, together with a responsibility not to install network features and functions that do not comply with the compatibility standards set forth in Sections 255 and 256 of the 1934 Act.[40] Section 251(b) imposes several duties upon all LECs including: 1) allowing other carriers to resell the LECs' services; 2) providing number portability; 3) providing dialing parity, discussed infra; 4) allowing reasonable access to the LECs' poles, ducts, conduits and rights of way; and 5) the establishment of reciprocal compensation arrangements for the transport and termination of telecommunications traffic.[41] Section 251(c) allows non-incumbent LECs to enter local markets in one of three manners: interconnection, access to unbundled elements, and resale.[42] Furthermore, Section 251(c), requires that incumbent LECs must: 1) negotiate in good faith binding agreements regarding their obligations under Sections 251(b) and (c); 2) provide interconnection to other carriers at any technically feasible point in their networks, at just and nondiscriminatory terms and at the same service quality the LECs provide to themselves; 4) allow resale of their services at wholesale prices; 5) provide reasonable notice of changes to their network; and 6) provide for physical or virtual collocation of facilities.[43]

Section 252 requires incumbent LECs to enter into voluntary negotiations upon receiving a request for interconnection from another carrier pursuant to Section 251(c).[44] If the negotiations are successful, the parties must submit the agreement to state/insular regulators for review and approval.[45] On the other hand, if the negotiations are unsuccessful either party may request that the state/insular regulatory commission mediate or arbitrate the proceedings.[46] In arbitrations, state/insular regulators must in turn resolve such interconnection disputes within 9 months of receiving the request.[47] The FCC will have the opportunity to participate in arbitrations upon the request by a party, the state or insular area, or by submitting a filing on its own motion.[48] At any time an aggrieved carrier may seek a declaratory ruling from the FCC regarding the practices or behavior of another common carrier[49] or may file a complaint with the FCC alleging that an incumbent LEC or requesting carrier has failed to comply with the 1996 Act or FCC rules.[50]

It should be noted that Section 251(f) allows those LECs which qualify as "rural telephone companies" to petition state/insular regulators for an exception from the interconnection and network access requirements set forth in Section 251(c).[51] In short, rural telephone companies[52] -- because of their size -- may not be required to meet the full interconnection requirements established in the 1996 Act. The exception may last until the rural telephone company receives a bona fide interconnection or network access request from another carrier, and the state/insular regulators determine that the request is not unduly economically burdensome, is technically feasible, and is consistent with the universal service goals set forth in Section 254 of the 1996 Act.[53] Moreover, rural telephone companies may in some instances petition state/insular regulators for a suspension or modification of their obligations under Section 251(b) or (c) where the obligations are found to be technically infeasible, unduly economically burdensome, would harm consumer interests, or where the request is generally in the public interest.[54]

2.4 Preemption of Competitive Barriers

One of the primary objectives of the 1996 Act is to preempt insular, state and local regulations that serve as entry barriers and which discourage an open, competitive national market for telecommunications. This objective is codified in Section 253 of the 1996 Act, which provides that "[n]o State or local statute or regulation, or other State or local legal requirement, may prohibit or have the effect of prohibiting the ability of any entity to provide any interstate or intrastate telecommunications service."[55] Section 253 further allows parties to file challenges with the FCC regarding statutes or regulations that they believe hinder competition.[56] If the FCC finds that the statute or regulation serves as a barrier to competition, the FCC must then determine whether it serves the permissible goals of advancing universal service, protecting public safety, or safeguarding consumer rights.[57] If the FCC determines that the statute or regulation fails these objectives, the FCC must then preempt (or invalidate) it to the extent necessary to open the market.[58]

It is not yet clear what types of existing statutes and regulations may be considered unjustifiable market barriers under Section 253. It is also not yet clear whether insular, state and local authorities will act on their own to scrutinize and modify or rescind those statutes which serve as active or passive roadblocks to competition.

While several preemption cases are pending before the FCC, two in particular involve the insular areas. In the first case, Guam Telephone Authority ("GTA") has refused to allow interconnection or resale of its services on the basis that GTA is a "rural carrier," and the Guam Public Utilities Commission ("GPUC") has petitioned the FCC to clarify whether GTA can legitimately claim this exemption.[59] GPUC's petition remains pending. More recently, GTA filed a petition under Section 253 for preemption of any Guam statute -- including the Organic Act of Guam itself -- that would prevent GTA from providing personal communications services ("PCS") in the CNMI.[60] As stated in their petition, GTA wishes to preempt a legal challenge to GTA's ability to provide PCS in another sovereign insular area, and has therefore requested that the FCC issue a ruling on the matter.[61] This petition also remains pending.

It is apparent that Section 253 will serve as a powerful weapon in the hands of any carrier that believes it has been unjustly prevented from entering a market. Since increased competition typically results in lower rates and increased quality, it is likely that consumers will benefit from the broad preemption of archaic, anticompetitive or discriminatory regulations. Such a deregulatory model may, with its attendant benefits, also serve as an example for other countries in the Pacific Rim.

2.5 Federal/Insular Division of Responsibilities

While some of the 1996 Act's provisions rearrange the 1934 Act's original jurisdictional lines by expanding federal responsibilities into historically intrastate issues such as interconnection and local competition,[62] the 1996 Act also preserves state and local regulatory authority and gives state and insular regulators a full plate of new and difficult assignments.[63] For example, Sections 251 and 252 assign state/insular regulators a large portion of the responsibility for supervising the move to open, competitive markets. In addition to mediating disputes and arbitrating interconnection agreements discussed supra, Section 252(d) specifies that state/insular regulators must determine "just and reasonable" rates for the interconnection of facilities and equipment in such situations.[64] The FCC rules establish complex guidelines by which the states and insular areas must establish prices for these options,[65] requiring prices that are cost-based, nondiscriminatory, and may include a reasonable profit.[66] The rules implementing Section 253(c) give state/insular and local governments the responsibility to regulate the public rights-of-way and to require fair and nondiscriminatory compensation for the use of the public property.[67] State/insular regulators are responsible for managing dialing parity and numbering issues,[68] determining the amount of the universal service discount given to eligible schools and libraries,[69] supervising the deregulation of payphone services,[70] and the establishment of public interest payphones,[71] among other responsibilities. Moreover, state/insular and local governments are still responsible for overseeing the public safety and welfare, guaranteeing the continued quality of telecommunications services, and for the safeguarding of other consumer interests, provided that the regulations they adopt are consistent with the 1996 Act and are competitively neutral.[72]

These tasks present an enormous challenge for regulators in the Pacific insular areas. The U.S. Pacific insular areas have until now operated largely without the superstructure of telecommunications regulations that has long existed in the mainland states. The governments of the insular areas will, therefore, have to run twice as fast and twice as far to guarantee that they are able to provide the market supervision, arbitration services, and rulemaking authority mandated by the 1996 Act.

3. NANP MEMBERSHIP

In a parallel development long sought by the CNMI and Guam governments, the U.S. Pacific insular areas have been admitted into the North American Numbering Plan ("NANP"), with formal incorporation to begin on July 1, 1997. While the admission of the Pacific insular areas was not mandated by the 1996 Act, it cannot be denied that the legislation was a catalyst that drove their often-delayed applications to a final, successful resolution. Simply put, once the 1996 Act specifically recognized that the insular areas were part of the domestic telecommunications market, it no longer made sense to categorize the Pacific insular areas as "international points" for dialing purposes. Passage of the 1996 Act gained the CNMI's and Guam's applications the strong support of the FCC, the U.S. Department of the Interior and the U.S. Department of State. This support helped persuade the North American Numbering Plan Administrator to approve the applications in April of 1996, roughly three months after passage of the 1996 Act.

NANP membership promises to bridge much of the CNMI and Guam's geographic isolation from the mainland United States. First of all, NANP membership will result in simplified dialing between the islands and the rest of North America, alleviating the confusion that has long accompanied the use of international dialing protocols to place calls to and from the insular areas. Second, NANP membership will guarantee that residents of the islands have access to the benefits of domestic call routing, which should increase the speed, convenience and affordability of using telecommunications services. Inclusion of the insular areas in the NANP will therefore improve their social and political integration with the contiguous United States.[73]

4. CONCLUSION

The 1996 Act provides a new telecommunications blueprint for the U.S. insular areas of the Pacific Rim. The insular areas stand to reap enormous benefits as a result of the 1996 Act, which incorporates them into programs that will variously reduce rates charged to consumers, promote universal service, facilitate competition, and open markets. When these benefits become clear, the 1996 Act may well serve as a model and a catalyst for regulatory reform throughout the Pacific Rim.

ENDNOTES

1. See In re IT&E Overseas, Inc. and PCI Communications, Inc., 70 R.R. 2d 1248 (1992). According to the FCC, "it is clear that the Communications Act was intended by Congress to apply, and applies, in every respect, to all radio and wire communications originating or terminating on the Territory of Guam, and that Congress gave exclusive jurisdiction over all interstate and foreign common carrier communications, originating or terminating on Guam, to this Commission (footnote omitted)." Id. at 1250.

2. See In re PCI Communications, Inc., 7 FCC Rcd. 63 (1992).

3. See In re Matter of Petition for Rulemaking to Implement Domestic Rate Integration Policies for the Commonwealth of the Northern Mariana Islands, Petition for Rulemaking to Implement Domestic Rate Integration for the Commonwealth of the Northern Mariana Islands, at 5-6 (filed June 7, 1995).

4. For example, the per-minute charges assessed for calls to the U.S. mainland by MTC were approximately five times as high as those charged by U.S. long-distance carriers in their highest rateband. See MTC Tariff FCC No. 1, 3rd Original Page 16B, dated February 1, 1996; see also Sprint Tariff FCC No. 1, 11th Original Page 168, dated December 16, 1994.

5. William H. Stewart, "A Demographic and Geographic Profile of the Commonwealth of the Northern Mariana Islands," at 1 (CNMI Department of Commerce, 1996).

6. Id.

7. 47 U.S.C. § 254(b)(3).

8. See Alan Siff, ISDNs: Shaping the New Networks that Might Reshape FCC Policies, 37 Fed. Com. L.J. 171, 200 (January 1985). See also J.F. Malone, "New Directions in Telephone Technology," Modern Office Technology (May 1985)(noting that the underdeveloped nations of the world, including those in the Pacific Rim, see

telecommunications as a way to grow their nations' GNPs and they are mimicking the United States because of its stature as the world's role model in telecommunications policy); "Latin America: Latin American Trade & Investment," Reuter Textline Euromoney Trade Finance and Banker International (April 30, 1995)(discussing U.S. influence over Mexican policies after NAFTA).

9. In re Implementation of Section 254(g) of the Communications Act of 1934, as amended, Report and Order in CC Dkt. No. 96-61, FCC 96-331, ¶ 66. (Aug. 7, 1996)("254(g) Report and Order").

10. 47 U.S.C. § 254(g).

11. See 47 U.S.C. § 153(40) (defining "state" to include the District of Columbia as well as U.S. territories and possessions).

12. 254(g) Report and Order at n.5, clarifying that the CNMI, Guam and American Samoa are encompassed within Section 254(g) of the 1996 Act.

13. Id. at ¶ 47.

14. Id.

15. Id. at ¶ 67.

16. Id.

17. The Guam/Northern Marianas Working Group on Rate Integration is a cooperative, unofficial organization consisting of representatives of the Governors of the CNMI and Guam as well as the IXCs that serve the region. The Working Group met during July and August of 1996 and adopted a series of resolutions intended to assist the rate integration of the CNMI and Guam. See 254(g) Report and Order at ¶¶ 64-73 (discussing the substance of the Working Group's resolutions).

18. Id. at ¶ 64.

19. See id. at ¶ 71. American Samoa informed the FCC that it believed that the rates for services provided to America Samoa already benefitted from rate integration. Id. This is a puzzling claim, since prior to Section 254(g) the only U.S. points included in rate integration were Alaska, Hawaii, Puerto Rico, and the Virgin Islands. Accordingly, as mandated by Section 254(g), the FCC nonetheless required that carriers serving American Samoa must do so on a rate-integrated basis by the same deadline as with the CNMI and Guam. Id.

20. Petition for Partial Reconsideration of IT&E in CC Dkt. No. 96-61 (Sept. 16, 1996).

21. Petition for Reconsideration and Clarification of GTE in CC Dkt. No. 96-61 (Sept. 16, 1996) and Petition for Clarification, Or, In the Alternative, Reconsideration of U S West, Inc. in CC Dkt. No. 96-61 (Sept. 16, 1996).

22. AT&T Corp.'s Petition for Reconsideration in CC Dkt. No. 96-61 (Sept. 16, 1996).

23. See 47 U.S.C. §§ 254(b)(1)-(7) (setting forth the principles and policies of universal service).

24. See id. at § 254(c)(setting forth the principles by which the FCC is to decide which widely-used services should serve as a benchmark level of services to subsidize for high cost or low income consumers); see also Preparation for Addressing Universal Service Issues: A Review of Current Interstate Support Mechanisms, Report of the FCC Universal Service Task Force, at 34-44, 50-65 (Feb. 23, 1996)(discussing current explicit, targeted support programs such as Lifeline and Link Up America, as well as the "Universal Service Fund" which supports the rates charged by high-cost LECs).

25. 47 U.S.C. § 254(b).

26. See id. at §§ 254(b)(6) (requiring support for advanced telecommunications services to schools, libraries and health care providers generally); § 254(h)(1)(A)(requiring general support for all services used by rural health care providers); and § 254(h)(1)(B)(requiring general support for all services used by schools and libraries).

27. See In re Matter of Federal-State Joint Board on Universal Service, Notice of Proposed Rulemaking and Order Establishing Joint Board, CC Dkt. No. 96-45, FCC 96-93, ¶¶ 3-12 (Mar. 8, 1996).

28. See In re Matter of Federal-State Joint Board on Universal Service, Recommended Decision, CC Docket No. 96-45, FCC 96J-3, at ¶¶ 3-12 (November 7, 1996)(stating principals of the expanded support mechanism).

29. See Recommended Decision at ¶¶ 28-54.

30. Id. at ¶¶ 91-92.

31. See id. at ¶¶ 458-61. The Joint Board concluded that general discounts allow schools the maximum flexibility to purchase services according to their respective needs. Id. at ¶¶ 547-74.

32. Id. at ¶¶ 462-465.

33. Id. at ¶¶ 466-467, 473-477.

34. See id. at ¶ 631 et seq. (discussing level of support and need for further information on the services to receive funding).

35. See Stewart, supra note 5; see also Recommended Decision at ¶ 127 (stating that a low or declining penetration rate may be an indicator that rate levels are not affordable) and ¶ 129 (holding that the per capita income of a local or regional area, and not a national median, should be considered in determining affordability).

36. See Stewart, supra note 5.

37. Id.

38. See U.S. Department of the Interior, A Report on the State of the Islands, at 41 (1996). Due to the soaring birth rate the enrollment in the CNMI's schools is expected to continue to rise sharply.

39. See Memorandum from Michael Condon to Dave Ecret, "The Joeten-Kiyu Public Library Information Technology Center: Internet Connection Overview," (Sept. 6, 1996). Schools in the CNMI must currently pay $42.00 per month for each phone line, $29.00 per month for Internet access, and $3.00 per hour of use. Library expenditures have amounted to $7,064 over the last 6 months for 4,940 Internet sessions (including e-mail sessions) at 5 different stations.

40. 47 U.S.C. § 251(a)(1)-(2).

41. Id. at § 251(b)(1)-(5).

42. Id. at § 251(c).

43. Id. at § 251(c)(1)-(6).

44. Id. at § 252(a)(1)-(2).

45. Id. at § 252(e)(1)-(6)(setting forth standards and timetable for review of agreements by state regulators).

46. Id. at § 252(a)(2)(parties may request that state regulators mediate disputed issues at any point in the proceeding) and § 252(b)(1)-(5)(parties may petition the state regulators for compulsory arbitration of disputed issues between the 130th and 160th day of negotiations).

47. Id. at § 252(e)(4).

48. In re Implementation of the Local Competition Provisions in the

Telecommunications Act of 1996, First Report and Order in CC Dkt. No. 96-98, FCC 96-325, ¶ 121 (Aug. 8, 1996)("Interconnection Order").

49. Id. at ¶ 125.

50. Id. at ¶ 127.

51. 47 U.S.C. § 251(f)(1)(A).

52. The 1996 Act defines "rural telephone company" to mean a LEC that provides service to any LEC study area that: 1) either does not include either: A) any incorporated area of 10,000 inhabitants or more, or any part thereof; B) any territory, incorporated or unincorporated, included in an "urban area" (as defined by the U.S. Census Bureau); or 2) provides telephone exchange service, including exchange access, to fewer than 50,000 access lines; 3) provides exchange access to any local exchange carrier study area with fewer than 10,000 access lines; or 4) has less than 15% of its access lines in communities of more than 50,000 as of the date the 1996 Act was enacted. See 47 U.S.C. § 3(47).

53. Section 251(f)(1)(A) also sets forth the procedure through which state regulators should process and examine such request to terminate a waiver. Id. at § 251(f)(1)(A).

54. Id. at § 251(f)(2)(A)-(B).

55. Id. at § 253.

56. Id.

57. Id. at § 253(b).

58. Id. at § 253(d).

59. In re Matter of Request of the Public Utilities Commission of the Territory of Guam for a Declaratory Ruling Concerning Sections 3(37) and 251(h) of the Communications Act, Petition for Declaratory Ruling, at 2-10 (filed Aug. 13, 1996).

60. In re Guam Telephone Authority, Petition for Preemption Pursuant to Sections 253(a) and 332(c)(3)(A) of the Communications Act, 1-5 (filed Oct. 4, 1996).

61. Id. at 3-7.

62. Interconnection Order at ¶ 24.

63. 47 U.S.C. §§ 253(b)-(d).

64. Id.

65. See Interconnection Order at ¶ 618 et seq.; see also 47 U.S.C. 252(d) (1996).

66. See Interconnection Order at ¶¶ 672-712.

67. 47 U.S.C. § 253(c).

68. Id. at § 251(e).

69. Id. at 254(h)(1)(B).

70. Id. at § 276.

71. Id. at § 276(b)(2); see also In re Implementation of the Pay Telephone Reclassification and Compensation Provisions of the Telecommunications Act of 1996, Report and Order, CC Dkt. No. 96-128 and 91-35, FCC 96-388, ¶ 264 (Sept. 20, 1996)(assigning states the responsibility for administering and funding public interest payphones).

72. 47 U.S.C. § 253(b).

73. Among other things, the CNMI and Guam will be listed in telephone books across the continental U.S.

NEW ERA FOR TAIWAN'S TELECOMMUNICATIONS MARKET AND FOREIGN TELECOMMUNICATIONS SERVICES PROVIDERS

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ABSTRACT

Taiwan, in its push to establish itself as an Asia-Pacific Regional Operating Center ("APROC") and to accede to the World Trade Organization, is gradually opening its telecommunications market to foreign participation. In January 1996, Taiwan passed a set of telecommunications laws intended to open the telecommunications industry and market to foreign telecommunications companies and investors. This Paper summarizes Taiwan's APROC strategy, reviews certain liberalizing measures of the existing telecommunications regime, and assesses restrictions on and opportunities for foreign telecom operators and investors in Taiwan.

I. TAIWAN'S ASIA-PACIFIC REGIONAL OPERATING CENTER STRATEGY

Taiwan is currently undergoing a transformation from an industrial, manufacturing-based export economy to a service economy. Due to factors such as changes in the global economy, the formation of the World Trade Organization ("WTO"), the growing economic regionalism in the Asia Pacific region, Taiwan is seeking to compete globally by establishing itself as an Asia Pacific Regional Operations Center ("APROC"). Taiwan's APROC strategy is two-fold: first, to attract local and foreign enterprises to make Taiwan their operational base for investment and business activities in the Asia Pacific region, including southeast Asia and the Chinese mainland; second, to transform Taiwan into a base for developing comprehensive economic and trade relations with other members of the Asia Pacific region. Key objectives for Taiwan include: liberalizing trade and investment to lower tariffs, removing non-tariff trade barriers; opening the service industry; facilitating the presence of foreign personnel in Taiwan; easing restrictions on capital movement to liberalize foreign exchange controls; and establishing a modern legal environment for the information society. Pursuant to its APROC strategy, Taiwan has targeted 6 industry sectors to develop into specific operations centers including telecommunications, manufacturing, air transportation, transshipping, financial, and media.

TELECOMMUNICATIONS OPERATIONS CENTER

Taiwan's objective in developing a telecommunications ("telecom") center is to take advantage of Taiwan's sizeable existing facilities to both improve the performance of the telecom industry and transform Taiwan into a regional hub for information networks and management. To achieve this, Taiwan's government has stated it intends to expedite the transformation of the domestic telecom infrastructure, open the domestic telecom market, and liberalize the telecom regulatory structure. The initial efforts of liberalization include the issuing of licenses to private sector for operation of CT-2 phone services in 1995.

II. NEW TELECOMMUNICATIONS REGIME: CERTAIN LIBERALIZING MEASURES

The new telecom legislation which was passed on January 16, 1996 by the Legislative Yuan ("LY"), Taiwan's law-making body, revised the 1977 amendments to Taiwan's original 1958 Telecommunications Law. The new legislation is comprised of substantial amendments to the Telecommunications Law ("Telecom Law") and the Statute for Organization of the Directorate General of Telecommunications of the Ministry of Transportation and Communications, and the enactment of the Statute for Organization of the Chunghwa Telecom Co., Ltd. The Directorate General of Telecommunications ("DGT") was previously both the regulator and the operator of telecom services in Taiwan. The new legislation divests the DGT of its former business role and restricts the DGT to a purely regulatory body. The Chunghwa Telecom Co., Ltd. ("CHT") was set up on July 2, 1996 as a corporation and it is to assume the business role from the former DGT. The Taiwan government has stated that it intends to privatize the CHT gradually over the next several years.

CLASSIFICATION OF TELECOM ENTERPRISES: Type I and II

The new legislation classifies telecom operating businesses into two general categories: Type I and Type II enterprises. Type I telecom enterprises can be further differentiated into Type I-A telecom enterprises which install land-based equipment and line facilities providing network transmission facilities, switching facilities, and auxiliary facilities, and Type I-B telecom enterprises which include wireless communications services, e.g. cellular phone, mobile data, pager, very small aperture terminal ("VSAT") and trunk radio. The Law authorizes the Ministry of Transportation and Communications ("MOTC") to also promulgate implementing regulations that govern the business scope, operations area, technical specifications, application and licensing procedures, and term of license of Type I telecom enterprises. Type II telecom enterprises include all enterprises, other than Type I enterprises, which include value-added network services ("VANs").

FOREIGN INVESTMENT LIMITS

The new legislation also provides for some foreign participation. The Telecom Law restricts foreign participation in a company providing Type I services to 20 percent. The Law also requires that the chairman of the board of directors must be a Taiwan national, and the majority of the board of directors and the supervisors must also be Taiwan nationals, i.e., the number of foreign directors and supervisors may number just under half of the board members and the supervisors. The Law, however, no longer restricts foreign ownership in companies providing Type II services. In addition, all of the directors and supervisors of a Type II telecom enterprise may be foreign nationals, so Type II telecom enterprises may be 100 percent owned and managed by foreign investors.

III. THE CURRENT TELECOM MARKET

The new legislation has partially opened Taiwan's US$5.4 billion telecom market to foreign participation. On May 1, 1996, the MOTC announced that five mobile services including cellular phone service, paging service, mobile data service, trunk radio service, and VSAT service were to be liberalized for private investment as early as 1996. Providers of cellular phones, pagers, mobile communications, and trunk radio services must first apply to the DGT for a license. The bidding process is comprised of a multi-stage review and will take place from September 1996 for several months. At present, 203 bids have been tendered for 53 licenses of cellular phone, pager, mobile data, and trunk radio services. (See Figure 1.) A 10 year operating license will be awarded to each successful bidder for trunk radio or mobile data license; a 15 year operating license will be awarded to each successful bidder for pager or cellular phone license.

Foreign telecom companies and investors are anxious to tap into a largely under-serviced market of over 21 million Taiwanese. Demand is expected to grow as Taiwan's population becomes more affluent. Real gross domestic product ("GDP") is projected to grow at an average of 5.5 percent per annum until the year 2000. With the exception of Japan, Taiwan has the lowest income gap in the region. The top quintile accounts for approximately 39 percent of all gross personal income. Taiwan's economy is becoming increasingly service-oriented. Exports have dropped 5 percentage points since 1990, and now account for about 37 percent of GDP. By contrast, service revenues are increasing and now account for just under 60 percent of GDP.

Today, there are more than 9 million telephone subscribers in Taiwan. Of these, an estimated 800,000 are owners of cellular telephones. (See Figure 2.) Some telecom industry participants estimate that at least an additional 250,000 individuals are on the six to eight month waiting list for a mobile telephone number (sources predict that by the year 2000, the cellular telephone market will more than double to 2 million subscribers). The current penetration of rate in Taiwan has great potential to grow. The current number of mobile phone users in Taiwan is estimated at no greater than 5 percent of the total population. In comparison, the penetration rate for other countries in the Asia Pacific include: Japan, 6.1 percent; New Zealand, 9.3 percent; Singapore, 9.5 percent; Hong Kong, 11 percent; and Australia, 16.3 percent. The penetration rate in Sweden is 25 percent for a population of only 8 million.

Figure 1: LICENSES TO BE AWARDED IN TAIWAN

(as of November 29, 1996)

1. Cellular Phone

MHz			**900**				**1800**		**Total**
Region	North	Central	South	Nation-wide	North	Central	South	Nation-wide	
Number of Licenses	1	1	1	0	1	1	1	2	8
Minimum Capital Req.	NT$ 2 Bil.	NT$ 2 Bil.	NT$ 2 Bil.		NT$ 2 Bil.	NT$ 2 Bil.	NT$ 2 Bil.	NT$ 6 Bil.	
Number of Applicants	11	4	5		9	1	2	10	42

2. Paging Service

MHz			**285**		Total
District	North	Central	South	Nation-wide	
Number of Licenses	2	2	2	2	8
Minimum Capital Req.	NT$200 Mil.	NT$200 Mil.	NT$200 Mil.	NT$400 Mil.	
Number of Applicants	7	6	6	13	32

3. Trunk Radio

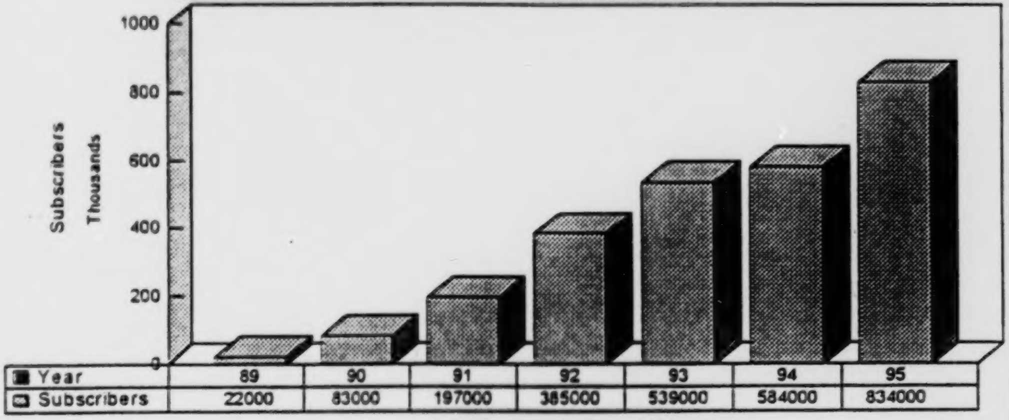
MHz			**500**				**800**		**Total**
District	North	Central	South	Nation-wide	North	Central	South	Nation-wide	
Number of Licenses	4	4	4	1	2	2	2	1	20
Minimum Capital Req.	NT$ 20 Mil.	NT$ 20 Mil.	NT$ 20 Mil.	NT$60 Mil.	NT$ 20 Mil.	NT$ 20 Mil.	NT$ 20 Mil.	NT$ 60 Mil.	
Number of Applicants	16	10	10	7	14	13	16	12	98

4. Mobil Data

MHz			**500**				**800**		**Total**
District	North	Central	South	Nation-wide	North	Central	South	Nation-wide	
Number of Licenses	4	4	4	1	1	1	1	1	17
Minimum Capital Req.	NT$50 Mil.	NT$50 Mil.	NT$50 Mil.	NT$150 Mil.	NT$50 Mil.	NT$50 Mil.	NT$50 Mil.	NT$150 Mil.	
Number of Applicants	5	5	4	4	4	2	3	4	31

Source: DGT

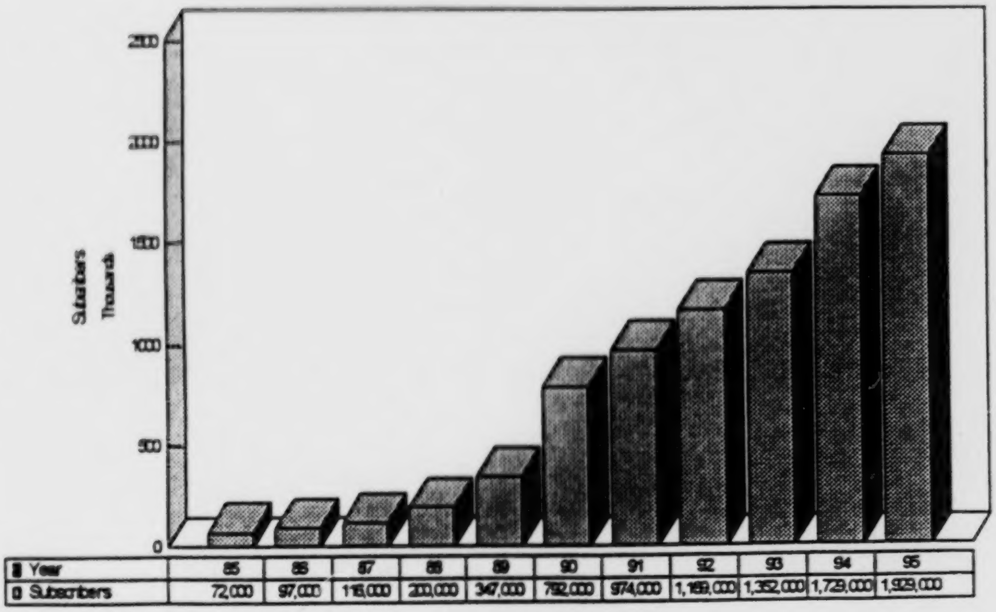
Figure 2: Cellular Subscriber Growth in Taiwan



Year	89	90	91	92	93	94	95
Subscribers	22000	83000	197000	385000	539000	584000	834000

Source: DGT, Coopers & Lybrand

Figure 3: Paging Subscriber Growth in Taiwan



Year	85	86	87	88	89	90	91	92	93	94	95
Subscribers	72,000	97,000	116,000	200,000	347,000	792,000	974,000	1,189,000	1,352,000	1,729,000	1,929,000

Source: DGT, Coopers & Lybrand

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It is estimated that by the year 2005, Asian cellular owners, who account for about 20 percent of world-wide users today, will probably represent up to 35 percent of world-wide users. The Taiwan paging market is predicted to grow from the present 2.5 million users to 5 million users. (See Figure 3.) Over the same period, the market for switching equipment and handsets alone is estimated at US$1.8 billion for cellular phone service and US$565 million for paging services. Much of this estimated growth is attributed to the effects of the new legislation's liberalizing measures.

IV. FACTORS INHIBITING FOREIGN PARTICIPATION AND INVESTMENT

Pursuant to Taiwan's APROC strategy, the DGT has taken several steps to restructure the telecom regulatory regime and to further privatize and liberalize the industry. But foreign telecom companies and investors have demanded that the DGT move more quickly to de-regulate the telecom industry and open it up to greater foreign participation. Despite the DGT's stated objectives to quickly liberalize, several barriers remain including:

Cap on Foreign Investment at 20 Percent for Type I Services: Foreign telecom companies are disappointed with the current 20 percent investment limit in companies providing services such as cellular phones, paging, mobile data communications, and domestic satellite communications. During negotiations prior to passage of the new legislation, telecom companies had pushed hard for a higher investment limit.

CHT Retains Unfair Advantage: Foreign telecom companies fear that the CHT retains significant advantages having once been part of the DGT. They claim that the DGT has reserved the best frequencies for CHT and has also restricted access to certain technologies. The DGT has also delineated specific regions in which operators can function. In addition, whether or not DGT can function as an impartial regulatory body is still uncertain at present. The CHT today controls 97 percent of the mobile telephone market and retains a monopoly on basic telephone services. Private operators also fear the imposition of unreasonable interconnection rates to the PSTN in Taiwan, which the CHT controls. They estimate that even when the industry is fully opened, CHT can probably retain up to 70 percent of the market.

As an existing monopoly, the newly established CHT is operating from a position of strength in terms of market presence (CHT has a strong customer base, e.g., 800,000 cellular phone users currently), industry knowledge and relations, resource occupation, spectrum allocation, and possible influence over its former colleagues at the DGT. Also, in the event of future frequency allocation for a new type of wireless service, foreign telecom companies fear that CHT may be able to obtain a nationwide special permit without having to undergo the grueling bidding and review process for licenses that other private industry players need to undergo.

Cross-Subsidies Prohibited: As of July 2, 1996, pursuant to the new telecom legislation, the DGT was divested of its operational role and a new corporation, CHT, was formed to take on the operational role from the DGT. Under the new legislation, the CHT will continue to be the sole carrier of basic telecom networks for at least several years. Foreign telecom companies and investors fear the potential for cross-subsidization despite the fact that the Telecom Law specifically prohibits cross-subsidization between Type I and Type II services. Under the Telecom Law, CHT is required to separately calculate the profit and loss for its Type I services and its Type II services, and is not permitted to cross-subsidize, i.e., a telecom operator may not subsidize the losses of a Type II service with the profits from a Type I service and vice-versa. However, no provisions of the Telecom Law expressly prohibit cross-subsidization between Type I services. It is too early to tell if the Law's provisions restricting cross-subsidies will be effective, and if the DGT can take any measures to avoid any cross-subsidies from CHT's PSTN operations to CHT's wireless operations.

Political Considerations in License Application Review Process: Doubts exist over the overall political impartiality and thoroughness of the review panel for license applications for Type IA wireless services. The inclusion of political party representatives in the 9 person qualification review panel, one from each of the 3 major political parties, KMT, DPP, and New Party, is viewed with skepticism. Potential applicants fear that the present of political party representatives would invariably introduce political issues into what should be an objective review. Also, applicants fear that since the review panel has had only a few months to review the numerous and technically complicated applications, the panel members may not give each application due consideration.

V. OPPORTUNITIES FOR FOREIGN INVESTORS: New Developments

Foreign companies and investors have sought to position themselves to take advantage of the on-going liberalization. Several consortia and joint ventures have been formed to participate in the bidding and review process. These ventures have been formed to share the financial risk, share technical and operational expertise, and to best utilize advantageous distribution coverage and local relationships.

Foreign investors are also seeking to increase their participation beyond the existing limits. Telecom companies are exploring entering into joint ventures with local Taiwan companies. Various avenues exist for foreign investors and telecom companies to maximize their participation and investments in the telecom market such as through licensing fees, offering preferred shares, and licensing of telecom equipment.

On-going Trade Negotiations: Foreign telecom companies and investors continue to demand greater participation in the telecom market through trade negotiations. During discussions between United States and Taiwan government representatives in mid-July, Taiwan responded to concerns that certain provisions in the Law are too restrictive and limit foreign investment.

Issues discussed by the representatives included removal of the profit cap (i.e., 11.5% on ROE), drafting of a new formula for tariff schedules, the existing 20 percent limit on foreign investment in Type I telecom services, and relaxing the existing debt/equity ratio for bidders for wireless services. A number of proposals are currently under heated debate. One proposal offered a liberal interpretation of ownership rules to treat as local firms all Taiwan-based holding companies with foreign ownership below 49 percent of total shares, thus allowing them to invest in the telecom industry. This redefined interpretation, combined with the 20 percent foreign investment limit, would mean that foreign companies could be permitted to hold up to nearly 60 percent of a telecom company in Taiwan.

VI. DGT'S RESPONSE

After separated from business operation, DGT has taken steps to respond to the concerns of private investors. DGT recognizes that, apart from its role over supervising telecom industries, its main duty is to protect consumer interests. DGT has reiterated its commitment to accelerate telecommunications liberalization and impartial enforcement of the Telecom Law to prevent CHT from taking anti-competitive measures and cross-subsidizing between Type I services. In addition DGT has announced that a new set of tariff regulatory system will be devised before the end of 1997 to rationalize the tariff structure of Type I and Type II services as well as replace the 11.5% profit cap.

VII. CONCLUSION

After two decades of providing leading telecom equipment, Taiwan now finds itself competing with other Asian nations to establish itself as a Regional Operating Center and to accede to the World Trade Organization. Taiwan's steps to liberalize its telecom industry has opened the market to some foreign investment, but telecom industry participants and foreign investors impatiently demand more. According to Taiwan's APROC strategy, additional liberalizing measures can be expected in the future. The resulting increased competition will expand the current telecom market and available services to the benefit of Taiwan's consumers.

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High-Speed Internet Access for the Residential and Small Business Market

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1. ABSTRACT

Emerging asymmetric high-speed technologies for Internet access over the existing copper plant, such as ADSL, are attracting increasingly serious attention for the residential and small business market. In order to realize the potential benefits of such technologies, they must be integrated both with the existing Internet architecture and with the existing telephony infrastructure. This paper reviews these existing constraints and describes four significant architectural alternatives for high-speed Internet access in this context: routing, bridging, switching, and Cells-in-Frame. From this foundation, it briefly reviews some opportunities and hazards in services and operations in the new environment, and illustrates a possible evolutionary route towards the integration of the Internet and telephony.

2. INTRODUCTION

This document describes technical solutions and architectural considerations for providing high-speed Internet access services to the residential and small business market while taking advantage of the existing telephony infrastructure and the lower-speed Internet access approaches already in use in this environment.

We will review typical architectural approaches currently being deployed to provide lower-speed (POTS and ISDN) access to this market, discuss the architectural alternatives for providing higher-speed access, and highlight both the opportunities for reuse of the existing infrastructure and the novel aspects that must be addressed in moving into higher-speed access technologies. ADSL technology, in particular, is shown to build upon the unique strengths of Local Exchange Carriers, stemming from their existing infrastructure and experience with conventional telephony and lower-speed Internet access services.

This article identifies and expands upon four of the main architectural alternatives for high-speed Internet access, in order to provide a more in-depth look at approaches to integrating high-speed consumer packet services with the Local Exchange Carriers' (LECs) planned broadband ATM infrastructure. The document then speculates on the services and applications platform that could enable Internet Service Providers (ISPs) to take advantages of the bandwidth abundance of such an enhanced LEC network. Moving beyond Internet access services, the report then focuses on the service implications of having consumer packet access and POTS services transported by the same subscriber loops. An Internet-based Computer-Telephony Integration (CTI) application is illustrated to show the service flexibility of the integrated consumer packet and POTS service platform. This integrated platform allows extensive reuse of the existing telephony and low-speed Internet access infrastructure, while providing significant new service opportunities.

3. CURRENT LEC-BASED ARCHITECTURE FOR LOW-SPEED INTERNET ACCESS

Despite minor variations across LECs, current technological limitations and regulatory constraints have restricted present LEC offerings of low-speed (POTS and BRI ISDN) Internet access services to share a common general design context and architectural skeleton. In this section, we will examine this service model at several levels of detail: first considering the general design context resulting from some common interpretations of the recent and current regulatory environment, and then focusing with greater emphasis on the infrastructure used to provide low-speed Internet access.

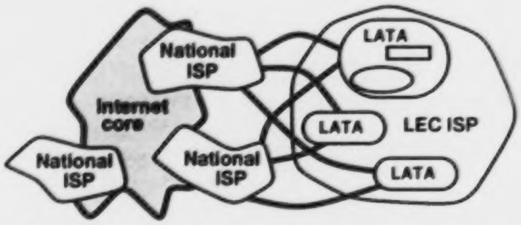

Figure 1. LATA-Fragmented Access Service Topology

Unlike other regional Internet service providers (ISPs), the LECs have until recently faced regulatory constraints that generally restricted their freedom to transport customer traffic across LATA boundaries and imposed some version of "equal access" for the providers of the inter-LATA and long distance Internet connectivity that their customers use. Although these constraints are subject to some variations in their interpretation, the fundamental effect has been to fragment the LEC-based Internet offering along LATA boundaries, as illustrated in Figure 1 (for a LATA-fragmented ISP offering, such as has been required for LEC architecture up until now) and Figure 2 (for an unconstrained regional ISP).

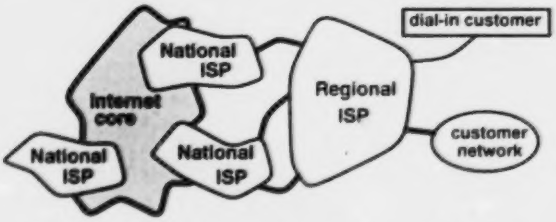

Figure 2. Conventional Regional Internet Service Provider Topology

Typical architectural consequences for the high-level model of a LEC-based Internet service offering are schematically presented in Figure 3. Customer Internet access in this model occurs through one or more Access Centers within each LATA; customer traffic from secondary Access Centers can be aggregated and delivered to a primary Access Center, which can coordinate traffic routing within the LATA, provide efficient support for authentication and resource tracking, and interface with the long distance Internet providers (LDIPs) that provide connectivity between LATAs and with the global internet. The schematic overview shows an explicit logical link between the LDIPs in order to emphasize that a LEC may require its LDIPs to provide fallback (multihomed) routing to ensure customer reachability in the event of failures in the links between individual LDIPs and LATAs. Depending on specific LEC business requirements, it is possible to have the same set of LDIPs connecting to all LATAs (in which case inter-LATA customer traffic can be routed entirely across these providers), or different LDIPs for different LATAs (in which case customer traffic between LATAs may cross some of the global Internet beyond the immediately connected LDIPs, unless these LDIPs have arranged direct interconnections). The number of LDIPs involved is also highly dependent on LEC business requirements and interpretation of the regulatory constraints.

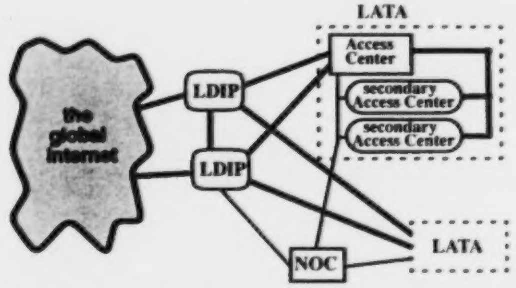

Figure 3. Schematic View of Present Internet Access Model

The Internet Network Operations Center (NOC) may use LEC facilities to connect to the Access Centers of all the LATAs to handle administrative traffic, but generally also relies on one or more of the LDIPs to provide its connectivity to the global Internet. Because this schematic illustrates only the logical connectivity of the access architecture, the actual physical connectivity may differ; for examples: there may be multiple NOCs, or separate Operations and Data centers, or no direct link from a NOC to any LDIP (with all NOC traffic to the external Internet going through one or more of the Access Centers). NOC and Data Center networks require more stringent security protection, and so are generally isolated by "firewall" machines from direct communication with the Internet or with the customer traffic. Because connectivity must be maintained between the NOC and the major infrastructure components (such as routers, servers, and firewalls) despite link failures, typical service models rely on the LEC-based network for normal administrative traffic, but are prepared to route across other Internet facilities in the event of a local failure. Alternatively, backup connection facilities may also be arranged using the public switched telephone network and POTS or ISDN modems.

The effects of the regulatory constraints also appear when one considers the architecture of an individual Access Center. Figure 4 expands the schematic view to focus on one primary Access Center, with both low-speed dial-in customers and dedicated higher-speed customers.The lower levels of the architecture are the same as for other Internet access providers, with a hierarchy of access servers and routers to provide traffic concentration and to localize traffic demands where possible. At the lowest level, Terminal Access Servers (TASs) terminate ISDN and POTS modem access, while various packet services (such as SMDS, Frame Relay, PRI ISDN, ATM, or leased line) provide direct connections to routers for dedicated-access customers. Higher-level routers are employed as needed, both for traffic aggregation and to support the route administration. The top-level routers within the Access Center connect to other Access Centers within the LATA, with per-LATA servers, and with the access routers for the LDIPs.

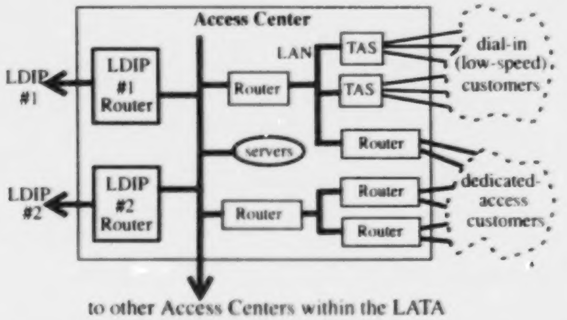

Figure 4. Schematic View of a Primary Access Center

At this level, the architectural effects of the regulatory constraints become more prominent. The complexity of the routing model greatly depends on the specific business model and the interpretation of "equal access": if a customers can specify his or her LDIP selection, then source-based routing or LDIP-specific access hierarchies may need to be employed. If "equal access" is provided by nondiscriminatory route sharing, with traffic directed to the "best route" LDIP for its particular destination based on the exterior gateway protocol information, then the Access Center may need to have a router at the top-level that exchanges full route tables with the LDIPs. In either case, each of the LDIPs maintains a point-of-presence (POP) router at the primary Access Center of each LATA. LEC facilities (such as SMDS, FDDI, Frame Relay or ATM) provide connectivity for customer traffic and routing information between the LDIP routers and the LEC routers within this Access Center as well as those in any secondary Access Centers in the LATA. Unlike other regional Internet service providers, however, the LEC's connectivity for customer traffic does not extend across its entire region.

Figure 5 further focuses the view on the architectural requirements for supporting low-speed dial-in access. By eliminating features from Figure 4 that are not involved in this service, additional aspects of the architecture can be included. Some of the details are largely a matter of administrative convention; for example, Terminal Access Servers may be dedicated to a single access technology (such as ISDN BRI), or may be configured with a variety of interfaces. Similarly, although reliability concerns may strongly suggest a redundant approach, the technology does not absolutely dictate the decision whether or not to provide direct access by the NOC to each router and access server, using a more secure, independent administrative network instead of relying on Internet connectivity and reliability. The non-dedicated nature of the low-speed access technology, however, does require that a customer's access be authenticated (and, depending on the charging model used, his or her resource usage monitored and recorded for future accounting input) whenever a dial-in connection is made. Thus, a protected Access Authentication and Accounting (AAA) server, supporting such industry standard protocols as TACACS (1) or RADIUS (2), is essential. To ensure local availability and response speed, the most common model is to place one or more AAA servers at each Access Center that supports non-dedicated access. Given such a facility, additional security may be obtained by using an administrative network to carry the messages between the TASs and the AAA server that establish access and record raw accounting data; trustworthy communications between the NOC and the AAA server are essential for maintaining timely and accurate access information for customer accounts.

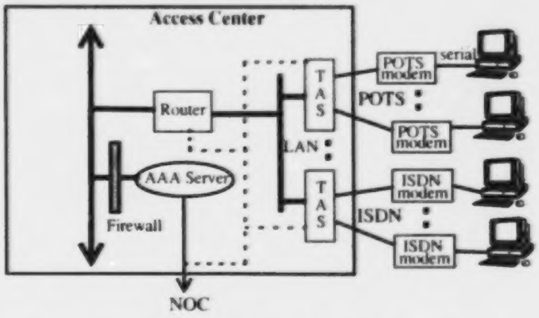

Figure 5. Architectural Support for Low-Speed Internet Access

Despite the possible alternatives for various details of the architecture, the overall structure is sufficiently constrained by technological and regulatory factors that it provides a fairly stable model for providing low-speed residential and small business Internet access. In the next section, we explore the architectural alternatives for high-speed Internet access in this market, so that the evolution from low to high speed can then be considered.

4. ARCHITECTURAL ALTERNATIVES FOR HIGH-SPEED INTERNET ACCESS

Although both ADSL and cable modem technology have been around for a few years, they had been developed primarily for interactive movies on demand. The interest in using such asymmetric, high-speed technology for

Internet access has become serious only recently, fueled by the phenomenal growth of the Internet and the popularity of World Wide Web applications. In this report, we shall focus on ADSL access for several reasons: it exploits the existing copper loop plant; it offers non-shared bandwidth to the consumer; it promises more reliable and less noise-prone quality of service; it offers convenient connection to central office facilities; and it allows simple (albeit limited) identification of the physical connection being used for access. ADSL modems, when deployed quickly, could serve many strategical and tactical business purposes for the LECs while new cable modems are being developed and cable plant updated. However, since most of the network planning efforts on ADSL have been done with movies on demand in mind, there is an urgent need to reconstruct a coherent end-to-end data model for Internet access applications and to relate this model to the LECs' existing low-speed Internet access service architectures.

4.1 SELECT THE "RIGHT" ADSL MODEM

ADSL modems provide data rates consistent with North American and European digital hierarchies and can be purchased with various ranges and capabilities. The current most common configuration provides a 1.5 Mbps downstream and a 64 kbps upstream channel. This configuration provides up to 18,000-foot distance coverage. Products with downstream rates up to 9 Mbps and duplex rate up to 640 kbps could become available by the end of 1996. The choice of a particular version of ADSL for Internet access applications depends on the services envisioned (e.g. WWW vs. low-bit-rate video conferencing), distance coverage of the existing loop plant, specific vendor features, pricing, and performance.

For Internet access services, one should note that a uniform bit rate for all modems used throughout the distribution network is not necessary, unlike the case of using ADSL for movies-on-demand applications. Bit-rate disparity is a fact of life in data communications. The use of routers and store-and-forward data buffers effectively provides speed conversions at each network node. In other words, time to market is a more important consideration for Internet access service than waiting for the ideal modem with the right speed. As a corollary, a desirable feature of a well-designed ADSL modem is the ability of the modem to adjust its speed downward automatically to accommodate the maximum speed sustainable by a particular subscriber loop. Selecting a common user interface (such as 10-Base-T Ethernet interface or ATM) for the modem is far more important than selecting a uniform bit-rate for ensuring end-to-end interoperability and a smooth transition path to an integrated communications backbone.

4.2 ROUTING, BRIDGING AND FAST PACKET SWITCHING

As noted in Section 2, current regulatory restrictions require LECs to create an equal-access environment and to place an application server in every LATA established for the switched voice network. These constraints effectively require them to adhere to the existing model for the switched voice network by creating Access Centers (most naturally colocated at some Central Offices) to terminate subscriber lines for collecting customer packet traffic; customer packet traffic is then routed over the LEC facilities to appropriate application servers, other customers within that LATA, or to the accessible long distance Internet access providers. These constraints, for now, also govern the feasible architectures for higher-speed access; however, for ADSL Internet access there are several choices for how the customer traffic is delivered between the ADSL interfaces and the local packet network facilities. Depending on the service provided by the access hubs, customer traffic can be routed, bridged or switched to the next hop.

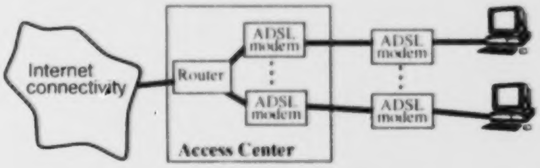

Figure 6. Internet Access Alternatives: Routing

Figure 6 depicts a configuration where individual ADSL lines terminate directly on an IP router. In effect, ADSL serves solely as the physical link between a specific router port and a specific customer loop. This configuration has the advantage of providing maximum interoperability between ADSL and other LEC-offered Internet access services (such as dedicated lines, dial-up, and mobile IP). The ability to switch customer traffic based on the information in the IP headers also provides application-level hooks for the LEC to support enhanced data services (such as Internet commerce). However, because routers are generally limited in their port density and router ports are comparatively expensive to be used on a per-subscriber basis, the approach is less cost-effective than the other alternatives such as Internet access via cable modems.

Figure 7 presents a variation of the above configuration that first terminates the ADSL modems on the Access Center end to an Ethernet (or other moderate-speed

LAN) and then feeds the aggregated traffic into a router.

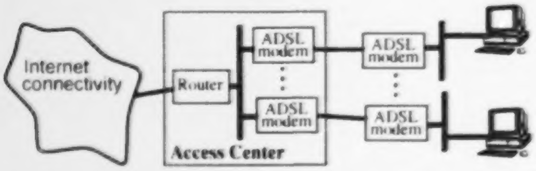

Figure 7. Internet Access Alternatives: Bridging

Multiple independent Ethernet segments can be used to terminate a large number of subscribers onto distinct Ethernet ports of the same router. Thus the cost of a router and router ports can be shared by a large number of subscribers. Note that the Figure 7 configuration relies almost exclusively on off-the-shelf networking components and is perhaps the most effective solution to be deployed immediately to counter the Internet-over-cable-modem competition in terms of cost, performance and time to market. In addition, if the Ethernet segments are replaced by an Ethernet switch (e.g. Cisco C5000), the traffic filtering function of the switch could provide a level of security for user data unmatched by the shared cable approach for cable modems. There are, however, some concerns from the perspective of conventional telephony service offerings, in terms of tariffing Ethernet service or exploiting the planned broadband (ATM based) service offerings. The close correspondence between Figure 7 and Figure 4 nonetheless suggests that a high-speed Internet access service based on this ADSL configuration could be highly consistent with the existing and planned LEC Internet services infrastructure for low-speed access.

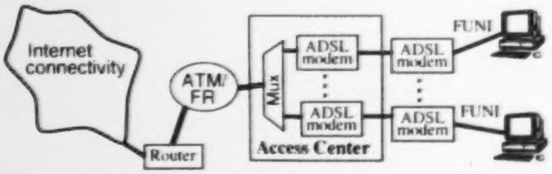

Figure 8. Internet Access Alternatives: Switching

Figure 8 illustrates an Internet access configuration that makes the maximum use of the OC3 ATM backbone envisioned by the LEC broadband service plans. Moreover, the ATM interface is extended all the way to the subscriber premises, via the Frame Relay User Network Interface (FUNI) or ATM UNI, resulting in end-to-end ATM service from subscribers to content providers as envisioned for Broadband ISDN. It is also widely believed that the end-to-end deployment of ATM will lead to a reduction in the cost of managing the LEC network.

4.3 CELLS-IN-FRAMES

To reduce the cost of ATM to the desktop, Cornell University has developed a Cells-In-Frames (CIF) technology. CIF was developed outside the ATM Forum, but several vendors are working on products based on the concept. Cornell plans to deploy ATM to their 10,000 node campus network by keeping 10Base-T Ethernet interfaces on most desktops, adding ATM software to the client PCs, and putting up to 31 ATM cells with one common ATM header inside each Ethernet frame. (For those with higher bandwidth needs, separate fibers will be deployed as needed.) Specially modified Ethernet switches will then be deployed as access hubs to accept the cell-bearing frames and convert the outgoing traffic to bona fide ATM cells for access to the ISPs and the LEC's backbone (see Figure 9).

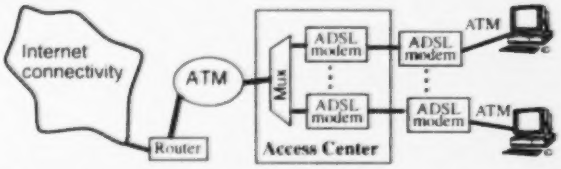

Figure 9. Internet Access Alternatives: Cell-in-Frame (CIF)

Several criticisms of the CIF proposal have been raised in the context of enterprise networking, where ATM Switched Virtual Channels (SVCs) are required for ATM layer desktop video conferencing as well as for LAN-to-LAN communications. It has been suggested that it is difficult to implement ATM quality of service (QoS) classes over Ethernet and that most existing PCs do not have the processing cycle to implement ATM signalling stack. However, in the context of Internet over ADSL, these drawbacks may not be as serious, because the environment is much simpler. Since subscribers may be required to presubscribe to their Internet access and content service providers, Permanent Virtual Channels (PVCs) may be sufficient for routing subscriber traffic, thus eliminating the need for implementing the ATM signaling stack and simplifying the QoS mapping from ATM to 10Base-T. The use of PVCs could also eliminate other internetworking complexities, such the need to have an Address Resolution Server (ARP) to dynamically translate between IP and ATM addresses.

The risk of aggressively pursuing the CIF approach (as opposed to the approach depicted in Figure 7) as the initial deployment architecture for Internet access could be substantial. While the design of the CIF components appears easy, the availability of commercial products could take a long time if it becomes necessary to gain the approval of ATM standards bodies before commercial manufacturing and deployment. As mentioned before, time-to-market as well as volume-to-market are the two necessary factors for any higher speed access technology (including ADSL and cable modem) to be accepted as a viable Internet access service for residential and small business customers. Nonetheless, when viewed as a transitional solution, the CIF approach to ADSL fills a natural gap between the Figure 7 architecture and the Figure 8 architecture, while providing a path for the eventual ATM fiber-to-the-home vision.

To summarize, two common features appear to be desirable among most deployment scenarios: 10Base-T user interface and fast packet transport (ATM or frame relay) for wide-area interconnection between COs and ISPs. Accordingly, other configurations as variations to the above architectural alternatives are entirely possible. The "best" architecture must be determined by a careful analysis of the services to be offered.

5. BEYOND HIGH-SPEED ACCESS

With the intense competition among ISPs for market share, Internet access service at any speed could become a commodity service bringing little operational profit for the service providers. This section briefly reviews some opportunities and hazards in services and operations when high-speed Internet access becomes widely deployed.

5.1 LOCAL SERVICE PLATFORMS

The current major ISPs are positioning themselves as online service providers as well as full Internet service providers. For the LECs to improve their revenue opportunities in this Internet environment, they may also decide to become more than transport providers by deploying application servers to provide services such as email spooling, NetNews, WWW, Internet search tools, electronic directories, Home Page hosting and application hosting. In this context, the current LATA-based fragmentation of the LEC Internet access architecture and its emphasis on comparatively localized Access Centers can in fact become a competitive advantage over conventional ISPs: access to and use of such services have strong locality, so that local service and local caching of global services (such as Web pages) can offer both highly visible performance benefits to the customers and highly efficient use of network bandwidth for the local Internet access provider, while substantially reducing the amount of traffic that traverses the less stable and more costly global Internet.

In addition to the above "me too" services, the LEC architecture can be exploited to provide increasing product differentiation from lower quality ISPs. The availability of high-speed, mass market Internet access creates a potential feedback environment in which local access networks may gain dramatic advantages over the long distance Internet. In particular, once a large number of subscribers are provided with high-speed local Internet access, the interLATA network could become congested because of the high volume of incoming traffic generated by simultaneous downloading using the high-speed downstream channels. Given a properly provisioned and configured intraLATA network, however, customers could continue to see high quality local access (and cached access to popular extraLATA services), so the demand for high-speed access service would further expand despite the difficulty in realizing the benefits of this higher speed across the LDIP and global Internet. In general, service speed can only be increased if the local access is complemented with sufficient trunking capacity in the global Internet. Moreover, due to the subscriber community of interests and the relative bandwidth scarcity over the long distance portion of the Internet, it is likely the service performance bottleneck will be a focused overload of a node in the wide area network or of a specific (though varying over time) set of content servers somewhere upstream of the LEC network. Thus local caching of Web contents and other information sources may be an important service that has marketable value to other content providers, in addition to its role in maintaining customer satisfaction with the access provider. Of course, the related security and copyright issues must be worked out beforehand.

5.2 REAL-TIME SERVICES

Once consumer packet service is available via Internet over ADSL or cable modems, real-time packet service could become an instant reality. First, there could be a natural migration of voice-band data (e.g. voice mail and fax) into the packet mode. Then one-way real-time applications such as Internet radio, low-bit-rate video simulcast or multicast could catch on very quickly.

There is debate on how much existing voice and video telephony services could be subject to competition from consumer packet services. One school of thought is that the long distance portion of the Internet will remain incapable of supporting good quality telephony services because of the lack of bandwidth and algorithms to guarantee quality of service. While the above observations may be correct regarding coast-to-coast Internet telephone calls, there are still other possibilities in local telephone service. For instance, with the recent passage of the new telecommunications bill, some CATV carriers have already been approached by IXCs regarding their willingness to carry packetized voice traffic to and from the IXC POPs. The quality of packetized voice using 32 kbps ADPCM and removable silence is quite acceptable and requires very little cable network bandwidth. Thus, if the long distance portion of the voice circuit is carried by the traditional POTS network, the end-to-end quality should be quite satisfactory.

Borrowing from the above argument, it is clear that low-bit rate video conferencing is also feasible with ADSL or cable modem, either as a local service or as local bypass using an IXC for the long haul transport. There are questions in the technical community regarding whether entertainment video, such as movies on demand, could be effectively carried by the Internet. This service could certainly achieve acceptable quality levels, although at a presently unknown cost, when real-time IP protocols such as RSVP become more mature in a few years. For the moment, a more practical solution is to provide a "dual-stack" approach using a separate channel to transport movies-on-demand while using Internet messaging capabilities for video program selection as well as other Internet services.

5.3 OPERATIONS SUPPORT

There are many operations support issues that need to be understood carefully: the provisioning and maintenance of the subscriber loops for ADSL services, configuring customer PCs for initial service, resource accounting, security and remote diagnosis, as well as network provisioning, administration, and trouble ticketing.

Assuming POTS will continue to be provided along side of ADSL on the same subscriber loop, it has been suggested in that ADSL maintenance can be treated as an add-on service to the existing, highly automated POTS provisioning and service assurance tools, such as the Automated Repair Service Bureau (ARSB) and work flow. Interestingly, once ADSL is used to transport TCP/IP, the link could also leverage over the operations support infrastructure developed for the Internet. Not only are commands like "ping" and "traceroute" generally available, but management information about network elements can be obtained via SNMP agents running on these nodes. Moreover, automated trouble ticketing systems such as the Remedy Action Response System are becoming de facto standard among ISPs. Accordingly, if it is possible to integrate the ADSL transmission media operations procedures with those existing for the Internet services, the end result could be a package that substantially reduces the operations costs of the Internet service providers as well as increasing customer satisfaction.

In terms of provisioning the Internet service over ADSL, many existing software tools for dial-up customers could be modified easily to deal with IP address assignment, routing and access control protocols, authentication, service selection, and billing. The Dynamic Host Configuration Protocol (DHCP) provides a standard framework for passing configuration information to hosts on a TCP/IP network (3). DHCP is based on the Bootstrap protocol (BOOTP), (4)(5), allowing the automatic allocation of reusable addresses and additional configuration options. However, if the Internet access service is priced to be a flat-rate service, customers are likely to keep their PCs turned on most of the time and their PCs would probably prefer static address assignments to the ARP (Address Resolution Protocol) function. Finally, the existing access control protocols used in current low-speed Internet access offerings, such as TACACS+ or RADIUS, are capable of authentication, authorization, and accounting services based user name/password information. Thus, these tools are applicable to ADSL without much change. Here again, the low-speed architecture of Figure 5 is directly compatible with the needs of high-speed access.

6. INTERNET AND COMPUTER TELEPHONY INTEGRATION

Once high-speed consumer packet access becomes a reality, it could become a trigger for the next wave of evolution for both the Internet and telecommunications infrastructures. Consumers would then have the bandwidth capability to do real-time video or audio communications (i.e., telephony) over Internet, blurring distinctions between computer networking and telecommunications. The ability to augment telephony systems with networked desktop computers gives subscribers easy access to telephony feature sets as well as the possibility of new multimedia communications, paving the way for a seamless integration of telecommunications and computer infrastructure. To illustrate the potential new service opportunities, we show in this section a strawman design that allows the integration of ADSL using a desktop computer equipped with Computer-Telephony Integration (CTI) boards to perform the following functions:

- Allow off-loading data traffic from the POTS network.
- Provide multimode messaging capability for the users.

- Facilitate new call features for individual subscribers.

6.1 ADDING "SMMART" TO THE SWITCHING INFRASTRUCTURE

One interesting problem that has recently attracted attention from many LEC network planners is the impact of Internet traffic on the POTS network. It has been observed that the switching infrastructure can be adversely affected by the long holding time of the modem calls, due to ISPs offering flat-rate access to the Internet. A natural solution to this problem is to offer consumer packet service so that modem traffic could migrate to the backbone packet service. A less obvious solution, applicable even before the consumer packet service becomes widely available, is to use a CTI computer as an adjunct to the Central Office (CO) switch to detect a modem call and allow one to bypass the circuit access via packet transport.

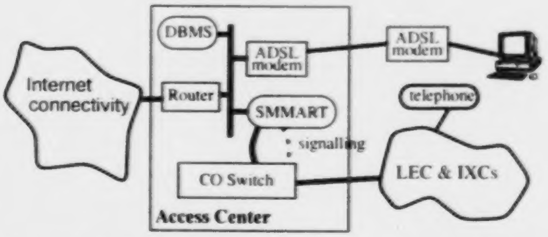

Figure 10. Adding "SSMART" to the Central Office

Figure 10 illustrates a design to add an intelligent peripheral to a CO switch to allow rerouting of modem traffic from the POTS network. The box labelled "SMMART" is a prototype CTI computer developed by Bellcore Applied Research that consists of a PC equipped with off-the-shelf Computer-Telephony boards, providing a bidirectional TDM bus with time-slot bundling capabilities and a separate messaging channel for signaling and control. The intelligent peripheral is connected to the switch via voice lines and a "CTI link" for all control, processing, and routing of the CO switch. The intelligent peripheral also has a large hard disk to store subscriber information for those served by the Central Office switch, as well as Internet access, via an Ethernet link or ATM service (as illustrated in Figures 7 and 8) to an ISP router.

When a subscriber makes an outgoing call, the local CO switch will pass the ANI/DNIS (the caller and called telephone numbers) and DTMF (other telephone numbers) to the intelligent peripheral, which uses the information to decide the nature of the outgoing call. For a regular POTS call, the intelligent peripheral will simply hand the call back to the switch. For modem calls to a particular ISP, the intelligent peripheral could then act as a modem bank and a PAD (Packet Assembly and Disassembly) interface to forward and terminate packetized information for the ISPs.

Such an intelligent peripheral must rely on a method to detect whether a particular phone call is a modem call. One possibility is to have the intelligent peripheral detect the carrier signal once the call is competed. The intelligent peripheral could then take down the call and reroute the traffic through the Internet. This approach may not, however, be desirable because of the overhead in call setup followed by a immediate call take down. Another possibility is to use the ANI/DNIS information to do a database search for a presubscribed request for PAD service. A third method is to use a Voice Response Unit (VRU) to collect additional dialed numbers from the subscribers to determine the desired features of a call. A careful trade-off study must be done to determine the most cost-effective method to identify a modem call and to trigger the PAD function for off-loading data traffic from the POTS network.

Note that the configuration depicted in Figure 10 uses the SMMART box at the back-end of the CO. While this configuration can alleviate the switch holding time problem at the ISP end, it still has the drawback of congesting the end-office class 5 switches. Another variation that could solve this problem is to design an intelligent access node that terminates access lines in front of a class 5 switch, while supporting call routing and packetization much the same as the SMMART box described above.

6.2 INTEGRATED INTERNET AND TELEPHONY

Figure 11 shows a combined ADSL- and SMMART-enabled POTS service architecture. By leveraging on the computer's graphical user interface, or incorporating a telephone call capability into a multimedia computer application, the following applications could be supported as new service offerings to the consumers:

- Screen-based telephony access to information (such as home banking);
- Intelligent unified voice mail with custom sorting based on speaker recognition;
- Integrated mobility support;
- Network server-based PBX with support for computer telephony;

- Virtual call center for telemarketing and office automation.

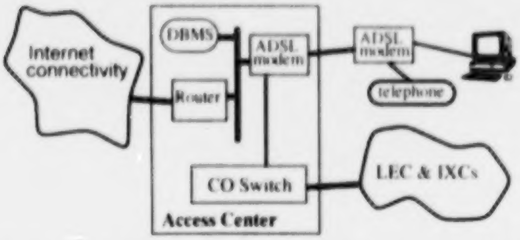

Figure 11. Integration of Internet Access with POTS

One should recognize however that the combined effect of integrating Internet with POTS via CTI is much more than just adding intelligent network features to the CO switches. As discussed in Section 4, the Internet is evolving into a real-time network capable of supporting voice and video applications. Once telephony starts to migrate into packet format, the multimedia capability of the Internet could provide many more flexible forms of user interactions, beyond simple voice telephony, for consumers and businesses. The fully-connected Internet is likely to be further enhanced to provide integrated signaling and management functions for highly distributed, multimedia communications.

7. CONCLUSIONS

Internet access over ADSL has gained tremendous momentum recently, with several trials currently in the final planning stage. However, most of these trials are technology trials, lacking the end-to-end service and operational components necessary for large scale deployment. This article provides a general framework and preliminary appraisal of these end-to-end issues. In particular, we examined the deployment of ADSL in the context of low-speed wireline subscriber access and POTS/Internet integration. The time-shared nature of low-speed dial-in access imposes some inconveniences both on the customer and on the service provider: for example, the customer typically sees a different Internet address (IP number) each time he or she connects, and the provider must authenticate the customer as a valid Internet client at each connection. The high-speed architectures described here (routing, bridging, fast packet switching, and ATM cells-in-frames), which exploit ADSL technology to provide dedicated contention-free bandwidth to the consumer as well as stable Internet addresses, can be directly integrated into the low-service offerings. While reusing much of the low-speed access architecture, they also offer the potential of integrating telephony and video-on-demand service with Internet access to the residential and small business markets.

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Intelligent Agents: Internet Usability Enhancers

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ABSTRACT

Intelligent agents are the basis for a usability revolution on the Internet. These software assistants, which allow users to delegate functions to be done that they otherwise would have had to do themselves, can automate, simplify, learn, and recommend ways to find the right answers without the complexity. This paper will describe a number of practical applications of intelligent agent technology to solve problems typically encountered on the Internet: e-mail overload, learning preferences for electronic shopping, web browser overload, and others. In addition, a recommended framework for adding intelligent agent function to any Internet application will be described.

1. Introduction

The Internet has depended on many technologies for its phenomenal growth: the underlying network itself, Hypertext Markup Language, and access to a world of content, to name a few. But continued growth into new worlds of less sophisticated users and "intranet" business users will require changes. Some changes will be in key infrastructure areas such as Internet security and electronic commerce enabling. But without advances in basic usability, the Internet is in danger of becoming so overwhelming to end users that its promises may never be fulfilled.

Intelligent agents are software that assists people and acts on their behalf. Intelligent Agents are well suited for enhancing usability in the Internet environment because the complexity of the Internet mirrors that of the physical world, where personal assistants (people) perform a similar role. These agents can, just as assistants can, automate repetitive tasks (such as checking web pages of interest), remember things you forgot, intelligently summarize complex data, learn from you, and even make recommendations to you.

Intelligent agents are *delegated* to perform some task(s), and given *constraints* under which they can operate. To accomplish these tasks, they may use four capabilities: *intelligence, agency, mobility* , and *user interface* (see Figure 1).

Intelligence is the degree of reasoning and learned behavior: the agent's ability to accept the user's statement of goals and carry out the task delegated to it. At a minimum, there can be some statement of preferences, perhaps in the form of rules, with an inference engine or some other reasoning mechanism to act on these preferences. Higher levels of intelligence include a user model or some other form of understanding and reasoning about what a user wants done, and planning the means to achieve this goal. Further out on the intelligence scale are systems that *learn* and *adapt* to their environment, both in terms of the user's objectives, and in terms of the resources available to the agent.

Agency is the degree of autonomy and authority vested in the agent, as measured by its interactivity. *User Interactivity* indicates a "standalone" agent which interacts only with user. *Application Interactivity* indicates interaction with user plus applications. *Agent Interactivity* indicates interaction with user, applications, and other agents as well.

Internet agent applications add a third dimension to the picture. *Mobility* is the degree to which agents themselves travel through the network. Some agents may be *fixed*, either residing on the client machine (to manage a user interface, for instance) or instantiated at the server. Other agents may be *mobile:* composed on one machine and shipped to another for execution in a suitably secure environment. Mobile agents may even be transported from machine to machine in the middle of execution, and carrying accumulated state data with them. Such agents may travel to *agencies* at which they can present their credentials and obtain access to services and data managed by the agencies. Agencies may also serve as brokers or matchmakers, bringing together agents with similar interests and compatible goals, and providing a "meeting point" at which they can interact safely.

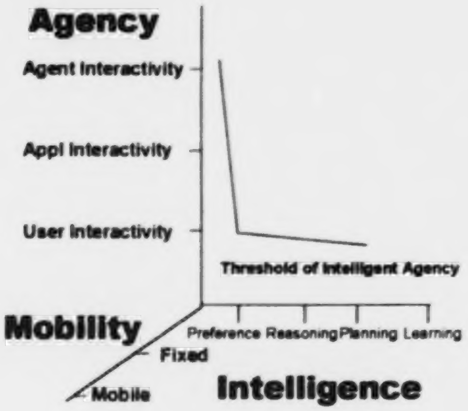

FIGURE 1: INTELLIGENT AGENT SCOPE

Mobility brings a host of security, privacy, and management challenges. Initially, applications will likely be built around fixed agents; mobility will appear gradually over time, as the infrastructure for agents matures.

Agents may work in the network, executing on a server on behalf of the user, or they may run directly on the user's computer. The fourth technology, *user interface*, is utilized when there is direct user interaction with an agent.

2. Intelligent Agent Attributes

The idea of *delegation* (1) sets agent software apart: Delegation passes some control from the initiator to the agent (similar in concept to asking a concierge to find theater tickets). Agents are incorporated within applications such as electronic mail, network management, and personal desktop tools. They differ from any other type of software because of the following characteristics:

1. Delegation: The user *entrusts* the agent to tackle some or all of an activity.
2. Personalization: The user determines how the agent interacts. In many cases, the agent learns about the user and adapts its actions accordingly (along the lines of a personal assistant).
3. Sociability: The agent is able to interact with other agents in ways similar to interpersonal communications: This includes some degrees of give and take, flexibility, and goal-oriented behavior.
4. Predictability: The user has a reasonable expectation of the results.
5. Mobility: The ability to go out—usually onto the network—to accomplish the delegated task.
6. Cost effectiveness: The benefits gained by the user (time, information, filtering, etc.) should be of greater value than the cost (monetary, time, re-work, etc.).
7. Skill: The agent has its own expertise. A simple agent may be capable of only executing a simple command containing no ambiguity ("Turn on the computer whenever I get a message"). On the other hand, the agent could have the ability to effectively deal with the ambiguity in the command, "find the best information about Fiji".
8. Living within constraints: This can be as simple as, "find me the suit, but do not purchase it", or become as complex as, "go only to the most likely information sources, since there is a fee to just access an information source". Some information services, for example, allow the user to set the maximum amount of money to be spent on any search.

3. Market State

"Agents will be the most important computing paradigm in the next ten years. . . By the year 2000, every significant application will have some form of agent-enablement" (2)

There are several reasons for this conclusion:

1. Desktop applications are becoming so "feature rich" that users can master only a small part of their capabilities. Agents mask the complexity and help the user do what he/she wants.
2. Sources of information are increasing, and their content is also increasing. Agents help do the data mining—as well as help locate the most productive mines.
3. Greater bandwidth means more data can get to you more quickly—but the user still has only 16 hours in the day available to work. Agents help manage the flow, by sending only the information *the user* considers essential.
4. Desktops and servers now are getting enough power to easily help users and processes.
5. Rapidly increasing use of the Internet and World Wide Web is creating a much more complex computing environment. Many people are beginning to refer to this as "network computing." This implies that we are moving from simple connections (i.e., a terminal-to-a-host, or a client-to-a-server) into the complex world of multiple servers and services interconnected like a highway network: Everything is available, but services change by the second, and the user has to figure out how to find them. Agents make a cohesive whole out of this stochastic world.
6. University and industrial research has now passed the point of mere theory, and experimental systems are freely available and in-use on the Internet.
7. Early adopters of commercial systems are giving a practical base for future application and commercial development.
8. Large custom applications are becoming agent-enabled, further broadening the experience base.

There are at least 50 vendors currently supplying agent-enabled software and services. They are spread across virtually every application area, including Internet applications. Customers fit into the market category called "early adopters": they take a niche, often technology-centric application, and figure out how to adapt it to their use. The challenge is to make it easy to add intelligent agents to *any* application, new or existing.

A recent market study (2) predicted when many people would be using agents, and when agent-enabled applications would be in widespread use. These predictions have been born out by the flood of agent-enabled applications announced in 1996; 1997 promises to move at an even faster pace.

Application Area	Many Use	Mainstream Use
Administrative Mgt	1997	1999
Collaborative	1997	1998
Commerce	1997	2000
Desktop Applications	1995	1998
Information Access / Management	1997	1999
Messaging (e-mail)	1996	1998
Mobile Access / Mgt	1996	1998
Network Management	1994	1996
User Interface	1997	1999

4. IBM Intelligent Agents

IBM is currently offering many applications on the Internet which are agent-enabled. From an analysis of the capabilities of some of these agents, one can see the many different ways in which agents can be utilized to enhance application usability.

4.1 World Avenue

World Avenue is the Internet electronic shopping service which offers benefits to both shoppers as well as "store owners" through intelligent agent technology. Intelligent agents that learn both browsing and shopping habits allow store presentation to be customized in a way most convenient to shoppers, while also allowing the store to "micro-merchandize." Intelligent data mining as well as automated accessorization are also offered as services to the merchants offering products through World Avenue.

Intelligent Miner is an intelligent agent system used as a part of World Avenue which utilizes a number of presentation and modeling techniques, including neural networks, to interactively perform pattern analysis on large amounts of data, and highlight patterns and features of interest. Further, user segmentation discovered using Intelligent Miner can be used for "social learning" (where information learned from users is applied to other users in the same segment), as well as associated buying.

4.2 Lotus Notes

Notes Agents in **Lotus Notes** Version 4 allow automation of many tasks within Notes. They operate in the background to perform routine tasks automatically for the user such as filing documents, sending e-mail, looking for particular topics or archiving older documents. They can be created by designers as part of an application to automate routine tasks such as progress tracking, reminders of overdue items, or perform more powerful functions, such as manipulating field values and bringing data in from other applications. Agents can either be private agents created by the user and used only by the user, or shared agents created by a designer and used by anybody who has access to the application or database. Both private and shared agents are design elements that are stored with the database for which they are created. They can be run manually by the user, automatically when certain events occur such as mail arriving, or scheduled to run at certain intervals. They can contain Notes simple actions, @function formulas, or a LotusScript program. Notes Agents are especially useful when used in conjunction with Notes' integrated WWW access function.

4.3 Web Browser Intelligence

The **Web Browser Intelligence** Agent ("Webby") adds agent intelligence to a web browser, allowing the user to remember wherever they've been on the web, what they found there, and can help them recall any word in any page that they've visited. It can alert a user, before they go to a page, whether the site is not available or the access time will be slow, via red / yellow / green "web traffic lights". It also helps them navigate more productively through the web by learning their preferences and patterns for searching for information.

Because of its tight connection to the user and the immediate presentation of results and changes on-screen, Webbie is implemented on the client system rather than on the server, as with many other intelligent agents. "Webby" is powered by intelligent agent user modeling technology from IBM's Almaden Research Lab, and is available for download at http://www.raleigh.ibm.com/iag/iaghome.html.

4.4 Knowledge Utility

Knowledge Utility (KnU) is a general purpose hypermedia system offering intelligent information retrieval and management. KnU allows groups of users to weave together all forms of data, connecting knowledge into meaningful patterns which aid users in retrieving appropriate information.

KnU allows an individual to identify interconnections among pieces of knowledge from different disciplines, and leaves a tangible and persistent record of that process of research and exploration. To accomplish this, KnU keeps user-specified relationships between data objects, allowing the users to receive information which is tailored to their interest pattern. Data returned to each user is automatically prioritized based on the preferences *learned* from that user, using Bayesian Networks (3).

The World Wide Web provides connections from within the Internet and remains largely read-only, so no additional connections can easily be made. KnU provides connections into and out of the Internet. Using KnU, users can connect from Internet objects to their own private data and back again, building an important knowledge base.

The *preference profiling* offered by KnU helps address information overload by personalizing information. The **Aqui** prototype, for example, personalizes Internet information connections and is built on KnU. Aqui can be found at http://knuaqui.stllab.ibm.com or on the IBM intelligent agent home page.

4.5 E-Mail Overload

E-mail is one of the biggest culprits for information overload on the Internet. Not only that, with the ubiquity of e-mail, it has become even more important to be responsive to important messages. IBM has a research prototype called the **Information Overload Assistant** which is designed to alleviate e-mail overload by allowing automatic categorization and action on e-mail based on user preferences. Built on the experience of several earlier products, this project uses the IBM Yorktown Research **RAISE** (4) rule-based intelligence technology combined with sophisticated learning technology to ascertain how the user handles e-mail and automate it.

4.6 Aglets

Java is a popular language for use in the Internet environment, not only because it is platform independent, but also because it allows use of *applets*.

Applets are small programs that are automatically downloaded and run as a part of accessing a Web page. IBM's Tokyo Research Lab has extended the applet concept into mobile agents in a project called **Aglets** (Agent Applets).

Based on Aglets, the *Aglets Workbench* (AWB) is a first-of-its-kind visual environment for building network-based applications that use mobile agents to search for, access, and manage corporate data and other information. AWB consists of the following components:

- Aglets, Java class libraries and tools to enable objects to move
- Jodax, a high level Java library to IBM's DB2 database
- JDBC, an ODBC-style library to RDBs
- Tazza, a visual GUI builder for Java

5. Framework for Agent-Enablement

5.1 Agent Building Environment

As exemplified above, there are many types of intelligent agents, as well as many ways to build them. Typically, for early adopter agent-enabled applications, agents are built into the application from the beginning, as other parts of the system are being developed. To facilitate quicker and easier agent-enablement for both new and existing systems, IBM offers the **Agent Building Environment (ABE)**, which can be downloaded from the Internet on http://www.raleigh.ibm.com/iag/iaghome.html.

Architecture is necessary to form an open environment in which agents can be added to existing applications, and agent parts, once developed, can be reused across many applications. ABE is based on such an architecture, shown in Figure 2. Its key parts include:

- **Engine** - the agent's :brains".
- **Knowledge** - what the agent knows, believes, and thinks, stored persistently in the **Library**.
- **Adapters** - the "eyes, ears and hands" of an agent.
- **Views** - the human interface to the agent, to instruct it what to do, for example.

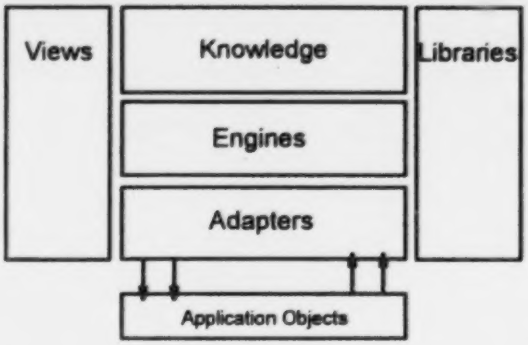

FIGURE 2: AGENT BUILDING ENVIRONMENT

The Agent Building Environment, as currently available, offers the following functions:

- A forward chaining inference engine, most widely used and required, to allow an agent to be rule-driven
- Knowledge stored in KIF (Knowledge Interchange Format) (5), an emerging standard. This allows, for example, more than one view component to input rules to the inference engine, as long as they are generated in standard KIF.
- KIF rule editor. Rules are stored in the Library.
- A set of adapters which allow common Internet applications to be built. Adapters include **Time** (sets alarms to trigger rules), **File** (observes and manipulates files), **HTTP** (casts the Internet HTTP domain in event - condition - action format), **NNTP** (allows monitoring and manipulation of USENET newsgroups) and **SMTP** (allows sending SMTP mail messages).
- A set of demonstration intelligent agents, including news filtering and stock quote monitoring.

In the future, additional components of the Agent Building Environment are possible, including learning (such as preference profiling, data mining, textual analysis, and social learning), additional adapters for key environments and functions, as well as views that automatically *generate* rules as a part of the intelligent agent.

5.2 Experience to Date

IBM is now using the Agent Building Environment, and earlier independent applications are now being folded into this. The architecture enables consistency, reuse of parts, and future flexibility in building new agent-enabled applications. Prior to the company's development and adoption of the Agent Building Environment, each agent application was designed independently. New IBM development is using the Agent Building Environment, and it is expected that this will be quite useful in the industry as well.

The value of an Agent Building Environment is broader, of course, than application design. The approach can enable use of new types of intelligence, adapters and views—from both within and outside of IBM, giving intelligent agent designers a choice of pre-made parts, as well as simplifying and reducing the costs of support.

IBM is actively working with several standards organizations to ensure the appropriate parts of the Agent Building Environment and related technologies are made as open as possible to facilitate widespread industry adoption.

6. Conclusion

Intelligent agents offer a new dimension of flexibility, user tailoring and usability to applications running in the Internet environment, but their individual construction "from scratch" can be tedious. Not only is IBM offering many pre-made Internet applications which use intelligent agent technology to enhance usability, it is also proposing use of a standard Agent Building Environment which allows system designers to easily add intelligent agents to both existing and new applications.

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Web sites with more information

IBM Intelligent Agents -http://www.raleigh.ibm.com /iag/iaghome.html

IBM Technology and Research - http://www.ibm.com /technology

Lotus - http://www.lotus.com

KnU - http://knuaqui.stllab.ibm.com

Security in Java™ and Java Enabled Web Browsers

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Abstract

The explosion of interest in the World Wide Web has lead many organizations to look at new ways of developing and distributing software. As a result, Sun introduced Java and the HotJava browser in March of 1995. Shortly after, Netscape added Java support to its Web browser. Java is an object-oriented programming language environment ideal for developing secure, distributed, network-based end-user applications. Both the HotJava and Netscape browsers are Web browsers which user Java to transform static data into dynamic applications, thereby making the Web "come alive". As this technology continues to gain widespread acceptance among Internet users, we must step back and look closely at the security implications of such a technology.

Although Java is an exciting enabling technology, recent problems show that it is not yet safe from hackers. Since its release, the Java language and both the HotJava and Netscape browsers which support it, have experienced several flaws which have led to the comprise of their security. These flaws are exploited via the code which is executed at the browser. Before companies will consent to bring over executable code from untrustworthy sources, they want to be assured that the code will not do anything malicious. Currently, companies must trust software vendors to correctly implement a security policy at the Web browser. In the future, the use of digital signatures may provide the mechanism needed to verify code coming from untrusted sources.

This document will provide a description of the Java language and also discuss the security features and issues raised by the Java language and Java enabled Web browsers.

1. Introduction

The explosion of interest in the World Wide Web (WWW) has led many organizations to look at new ways of developing and distributing software. Most client-server applications today are designed with specific client architectures in mind (e.g., Mac, OS/2 Warp, Windows, or UNIX). To make any changes, you typically have to re-install all new software, or upgrade on a client by client basis. In addition, the Web provides access to an enormous amount of information. Unfortunately, everything presented in a Web page is completely static. The WWW and the Internet provide the perfect basis and platform for a technology that could change all of that. As a result, in March, 1995, Sun Microsystems released Java on the Internet.

Java is an object-oriented programming language environment ideal for developing secure, distributed, network-based end-user applications. It is a simplified open-system language (based on C++) that allows software developers to engineer applications that can be distributed over the Internet using the World Wide Web. It is also an interpreted language, and therefore needs a run-time system on every computer on which the applications are going to be run. The run-time system, or interpreter, can exist both inside other programs, such as a WWW browser, or stand alone. It will eventually allow all of the Java-based applications to become ubiquitous, that is, to run anywhere and everywhere, regardless of the underlying hardware or operating system. The run-time system allows Java applications to run unmodified and without recompiling on any platform across any number of networks.

Java brings dynamic and interactive capability to the WWW, turning the Web into a new and powerful business and communications tool for all users. With Java, Web servers can transmit more than just static HTML data out to client users. They can transmit small programs called "applets" that when combined together on the client's machine can produce full-fledged interactive applications, thereby making the Web "come alive." Applets provide WWW users with ready access from their local system to additional web page content that can be delivered in a more visually compelling way, such as through the use of animation. The Java complier generates architecture independent bytecode instructions that run on any machine with a Java run-time system (i.e., interpreter). The Java interpreter takes these bytecodes and quickly translates them into machine code on the fly. The interpreter then executes the code on the target machine. Instead of viewing Web pages full of static information, developers can make visiting a Web page an interactive experience for users.

Java is very similar to any other object-oriented programming language. Applications developed using Java can be developed using C++ and vice-versa. A major area where Java differs is in its ability to have pieces of code scattered all over the Internet. Therefore, pieces of code must be downloaded from the Internet to the client machine and then executed. This feature, as one can imagine, poses a security threat. There are no guarantees that the downloaded program won't do something malicious such as erase your file system or mail back your password file.

Java does claim to be secure. The language has a built in layered security system that provides maximum security on public networks by safeguarding against viruses, tampering, and other threats. In addition, Java enabled Web browsers can implement their own security policies that can determine what an applet can and cannot do after it has been downloaded. However, even with all of the security features, Java is still a new technology. And with a new technology, comes a period of time where bugs and problems are discovered and fixed. Recent security vulnerabilities in implementations of Java enabled Web browsers prove this very exact point. As a result, organizations have been forced to think twice about this new technology. With this in mind, it is important that we take a step back and focus on the security implications of such a technology.

This document provides a description of the Java language and currently available Java enabled Web browsers and also discusses the security features and issues raised by both the Java language and Java enabled Web browsers. After a brief description on the potential usage of Java on the WWW, the document moves on to discuss the difference between applets and applications, the potential security threats, security in the Java language, security in Java enabled Web browsers, and finally the future of security in Java.

2. Potential Java Usage on the WWW

The distributed nature of the Web and emergence of Java have forced many organizations to rethink the way applications are developed and distributed to clients and executed. For many organizations, using Java translates into drastic reductions in the effort needed to install, support, and upgrade applications. The inherent portability of Java allows organizations to develop and distribute applications throughout their company and to external clients, in many cases just by putting it up on a Web page. Other interesting uses of Java in the context of the Web include but are not limited to the following:

- Publishing - Several organizations have begun publishing graphics and textual information on the Web.
- Client/Server Application Development - Java provides a simpler way for organizations to develop client/server applications. It is a an alternative to using C++ for developing distributed applications that will run across internal networks.
- Data/Information Access - Java provides an easy way for organizations to simultaneously deliver business information to both internal and external customers.
- Office Productivity Tools - Several organizations have announced their intent to integrate Java into their products. The HotJava browser is the first application coded in Java.
- Visualization of Data - Applications often require the visualization of complex data. As the data changes, so does the image computed from the data. Instead of constantly sending updated images through the network, a Java program could simply receive the changing data and compute locally the image to be displayed.
- On-Line Transactions - Although currently a small market, electronic commerce will play an important role in the next couple years. Java can be used to develop transaction-based applications.

3. Applets vs. Applications

The first thing to decide is whether to write applets or applications. The Java programming language was developed to be used for both stand alone applications and applets that are executed by Java enabled Web browsers. The security implications are quite different in each case. This section describes the difference between applets and applications and the security implications of choosing one over the other.

3.1 Applets

An applet (i.e., mini-application) is an interactive program written in the Java language which is either loaded over the network or from the local file system and executed inside a Java enabled browser. Applets can be downloaded from any server and run safely on any platform. They provide a huge range of new functionality: animation, live updating, two-way interaction, and more. Applets are restricted to graphical browsers and generally require a high-bandwidth connection with lots of memory on the client side. Some capabilities applets have and applications don't include the following:

- applets can play sound.
- applets running within a Web browser can easily cause HTML documents to be displayed.

- applets can invoke public methods of other applets on the same page,
- applets loaded from the local file system have none of the restrictions that applets loaded over the network do.

Applet Security

What about security? The problem of verifying and executing code downloaded from an untrusted site is not new. There are no guarantees that such a program won't steal your password or delete a critical file. Even when the software comes from a respected vendor, it can be modified as it is transported over the Internet. To address this problem, the Java language itself was designed to be secure (see Section 5). Additionally, the Java enabled Web browser (see Section 6) that downloads and runs the Java code is responsible for controlling and restricting the access (to resources on the host machine) that the untrusted program has. The goal is to ensure that untrusted applets can't steal or damage information on a computer running a Java enabled browser.

For some Web browsers, security restrictions applied to applets also depend on whether the applet was loaded over the network or loaded from the local file system. The way an applet enters the system affects what it is allowed to do. Applets loaded over the network are subject to the restrictions enforced by the browser's implementation of the applet SecurityManager (described in Section 5.4). In general, applets loaded over the network are prevented from reading and writing files on the client file system, and from making network connections except to the originating host. Applets are also prevented from starting other programs on the client. They cannot load libraries or define native method calls. All of the restrictions are entirely dependant on the security policy implemented by the Web browser.

On the other hand, applets loaded via the file system are allowed more flexibility, since they are considered to be trusted. Capabilities include the ability to read and write files, load libraries on the client, create (i.e., fork) processes and bypass low level security checks. Other specific capabilities denied to applets depend on the security policy implemented by the Web browser.

3.2 Applications

Applications can execute by themselves without any need for a Java enabled Web browser and do not have such restrictions such as not being able to write to files on the host. Applications cannot be embedded into an HTML page and therefore require Sun's Java Developers Kit environment to be present. As of the writing of this document, the Java Developers Kit (JDK 1.0) is only available on three platforms: SPARC/Solaris 2.3, 2.4, or 2.5, Microsoft Windows NT, and Microsoft Windows 95. Work is currently under way by several large software companies to port the JDK to other platforms.

Application Security

As with any other application developed using an object oriented programming language, the security implemented is entirely dependent on the developers of the application. As an example, let's take a look at the Netscape Navigator 2.0 Web browser. The Navigator Web browser is simply an application whose implementation denies an applet access to the local file system. Similarly, developers and organizations can choose and implement their own security policy for determining what an application is allowed to do. To assist developers in incorporating security, the Java language provides its class library. The SecurityManager (see Section 5.4), which is part of the class library, is the main Java mechanism for enforcing access restrictions. It is responsible for controlling access to critical system resources. A developer can use the SecurityManager to catch all potentially threatening operations before they are executed. The SecurityManager provides a developer with the security checks needed to implement a security policy for the application.

4. Security Threats

This section discusses some of the possible threats that users may encounter from executing applets downloaded from untrusted sites. Note that this is not intended to be a complete list in terms of possible types of attacks, but provides examples of the types of problems that can arise. An applet's ability to perform any one of these attacks successfully is dependant on the security policy implemented at the browser. The lack of a standardized security policy has resulted in some browsers having implemented stricter policies than others.

4.1 Trojan Horses

A trojan horse is any program that secretly performs other functions while performing its normal operation. Examples include:

- an applet that plays sound, but also discretely searches the user's local file system and sends back interesting files across the network,
- an applet that displays an animation, but also opens an xterm window across the network, with the display at

the remote site. The attacker can then execute arbitrary commands on the user's machine.

- an applet that plays a game with the user, but also captures keystrokes intended for other applications and transmits them back over the network.

4.2 Viruses

A virus is a program which copies itself surreptitiously into other code on the system, causing annoyance and sometimes total destruction of data. Examples include:

- an applet that loads a program into memory so that all applications accessing the system memory are infected and corrupted.
- an applet that waits for other systems to connect and then spreads itself affecting other systems on the network.

4.3 File System Access

An untrusted program with unrestricted and unauthorized access to the local file system can pose a major security threat. Examples include:

- an applet that deletes and modifies files,
- an applet that modifies memory currently in use,
- an applet that kills processes or threads currently in use.

4.4 Disclosure

A disclosure attack is a program which can view sensitive information on the system or network. Examples include:

- an applet that mails sensitive information about your machine (e.g., /etc/passwd) across the network to an attacker's site,
- an applet that sends personal or company files to an adversary or competitor over the network,
- an applet that acts as a sniffer and sends back to an attacker's site its collection of captured logins and passwords.

4.5 Network Access

A program which is arbitrarily allowed to connect to any machine on the network poses a security threat. Examples include:

- an applet that launches an internal attack on a firewall protected network.
- an applet that opens an xterm connection across the network and redirects the display to the attacker's site.
- an applet that starts a "chain letter."

4.6 Denial of Service

Denial of service occurs when a malicious piece of software acquires excessive amounts of resources causing legitimate requests to be consequently denied. Example include:

- an applet that busy-waits consuming CPU time,
- an applet that allocates large amounts of memory until the system's memory runs out,
- an applet that creates thousands of windows on the user's machine,
- an applet that creates and spawns thousands of threads, starving other threads and processes.

4.7 Annoyance

An annoyance attack is a program whose operation prevents a user from accomplishing normal activities. Examples include:

- an applet that displays objectionable pictures on your screen,
- an applet that plays unwanted sounds over your computer.

5. Security in Java

The security mechanisms present in Java act at four different levels of the system architecture. First, the Java language itself was designed to be safe, and the Java compiler ensures that source code does not violate these safety rules. Second, all bytecodes executed by the Java runtime engine are screened to be sure that they also obey these rules. This prevents an altered compiler from producing code that violates the safety rules. Third, the class loader ensures that classes don't violate name space or access restrictions when they are loaded into the system. Finally, API-specific security prevents applets from doing anything malicious. The remainder of this section describes how each layer works.

5.1 Language and Compiler

The Java language and its compiler act as the first line of defense. Unlike other C-like languages, the Java language does not use pointers. In other languages, the misuse of pointers has often led to modification, duplication, or spoofing of objects. In addition, runaway pointers (i.e., pointers that start modifying some other object's memory) have been responsible for a large percentage of security problems encountered.

To offset the loss of pointers in Java, new array facilities have been created. The array boundary points are strictly enforced, allowing the language to catch more bugs for the programmer. These bugs in other languages would probably lead to unexpected problems. Therefore, the language definition and the compiler create a fairly strong barrier against malicious Java programmers.

5.2 Bytecode Verifier

The bytecode verifier acts as the second line of defense. As bytecodes are downloaded over the Internet, the bytecode verifier has no way of determining whether the bytecodes were generated by a trusted compiler. Therefore, it must verify that they meet all the safety requirements. Before running any bytecodes, the bytecode verifier runs a rigorous series of tests that vary in complexity from simple format checks all the way up to running a theorem prover.

Aside from simple format checks, the bytecode verifier checks[4][7]:

- that it does not forge pointers,
- that is does not violate access restrictions,
- that objects are accessed as what they are,
- that methods (i.e., functions) get called with appropriate arguments of the appropriate type,
- that there are no stack overflows.

By the time the bytecode verifier has done its work, the Java interpreter can proceed, knowing that the code passed to it is in a fit state and will run securely.

The bytecode verifier is the crucial piece of Java's security, and it depends on having a correctly implemented runtime system. As of the writing of this document, Sun and Netscape have produced secure Java runtimes. In the future, organizations need to be careful when downloading or otherwise obtaining another company's version of the Java runtime environment. Eventually, Sun will implement validation suites for runtimes to be sure that they are safe and correct. But as for now, organizations need to be careful.

5.3 Class Loader

The class loader is another level of defense. It acts at a level higher than the bytecode verifier. When a new class is loaded into the system, it must come from one of several different domains. In the current release, there are three possible domains:

- your local computer,
- the firewall-guarded local network on which your computer is located,
- the Internet.

Each domain is treated differently by the class loader. The class loader never allows a class from a less-protected domain to replace a class from a more protected domain. No class from outside of your computer can take the place of the classes in the local-computer domain and spoof Java code into using nasty versions of defined methods. In addition, classes in one domain are not allowed to call upon the methods (i.e., functions) of classes in other domains, unless those classes have explicitly declared those methods public. This prevents downloaded applets from accessing methods present in local classes.

Another feature of the class loader involves the placing of downloaded applets into a separated package-like namespace. The class loader enforces the Java name space hierarchy. It guarantees that a unique namespace exists for classes that come from the local file system, and a unique namespace for classes that come from the network. As a result, applets are protected even from each other. No applet is allowed to access another's methods (or variables) unless explicitly defined. There is no way for an imported (i.e., network downloaded) class to "spoof" a local class.

5.4 The SecurityManager

At each stage, more and more security is added. The top level of security is the Java class library itself. The applet SecurityManager is the Java mechanism for enforcing the applet restrictions. It is responsible for controlling access to critical system resources. The SecurityManager must approve all potentially threatening operations before they can be completed. For those operations that are not allowed, the security manager throws a SecurityException. The SecurityManager contains a number of methods intended to be called to check specific types of actions. All applications implement their security policy through the SecurityManager.

Applets are subject to the SecurityManager of the Web browser (e.g., Netscape Navigator 2.0, Applet Viewer). The SecurityManager is established at start-up, and it cannot thereafter be replaced, overloaded, overridden, or extended. Applets cannot create or reference their own SecurityManager. This allows a Web browser to implement a specific security policy. It is important that the Web browser's SecurityManager is implemented correctly. In the extreme, if a Java enabled browser did not install a system SecurityManager, an applet would have the same access as a local Java application. The security policy of an applet or stand alone application can be made arbitrarily complex since the SecurityManager provides a flexible interface. A poorly implemented SecurityManager can lead to potential vulnerabilities as we will see in Section 7.

6. Java Enabled Web Browsers

As discussed in the previous section, the Web browser itself plays a large role in the security of the system. The Web browser defines and implements the security policy (through the SecurityManager) for running downloaded Java applets. A Java enabled browser will include a Java interpreter and runtime library along with classes added to implement a SecurityManager and various ClassLoaders. What sets it aside from other browsers is that it has the unique capability to execute interactive content embedded in HTML pages. Because system security is an integral part of the Java language, several browsers have been designed to ensure the security of the user's system and network. As of the writing of this document, three Java enabled browsers exist: HotJava, Netscape Navigator 2.0, and Sun's Applet Viewer. Each is discussed in detail below.

6.1 HotJava™

HotJava is a World Wide Web browser initially developed by Sun Microsystems to demonstrate the capabilities of Java. It is written in Java and is one of the primary interfaces to Java applets. It serves as an extended Web browser capable of running Java applets. Building on the browsing techniques established by Mosaic™, the HotJava browser expands on them by implementing the capability to transform static data into dynamic applications.

Since its introduction, the Java language has progressed through several releases (alpha, beta, beta2, Release 1.0). The HotJava browser, developed to run applets created during the alpha release, has remained in the alpha release. It is therefore incompatible with all Java releases after the alpha release. It will not work with applets created using the latest release of the Java Developers Kit(JDK). As of the writing of this document, the browser is limited to viewing alpha applets, so it is not useful for those organizations working with the latest release of the JDK. Sun Microsystems plans to release a version of its HotJava browser that will support and be compatible with the latest release of the JDK sometime in the second half of 1996.

6.2 Netscape Navigator 2.0

Netscape Navigator 2.0 is a World Wide Web browser developed by Netscape Communications Corporation. Its newest release combines the capabilities of the World Wide Web, electronic mail, chat, and file transfer services together in an integrated package. In addition, Release 2.0 now supports Java on Sun Solaris, Sun OS, SGI IRIX, OSF/1, HP-UX, Windows NT, and Windows 95 platforms. Java support for Windows 3.1, Macintosh, and AIX is expected some time in the second half of 1996.

6.2.1 File I/O Security

Applets are not allowed to read or write files at all in Netscape Navigator 2.0.

System Properties

However, applets are allowed to read certain system properties (in order to find out about the current working environment) by invoking the **System.getProperty(String key)** method. Table 6-1 lists the system properties available to an applet. Table 6-2 lists those system properties not accessible to an applet.

key	meaning
java.version	Java version number
java.vendor	Java vendor-specific string
java.vendor.url	Java vendor URL
java.class.version	Java class version number
os.name	Operating system name
os.arch	Operating system architecture
file.separator	File separator (e.g., "/")
path.separator	Path separator (e.g., ":")
line.separator	Line separator

Table 6-1. System Properties Available To Applets

Currently there exists no way to prevent an applet from reading the system properties listed in Table 6-1. Normally, a user would be able to modify the property in the *~/.hotjava/properties* file but Netscape Navigator 2.0 prevents the reading or writing of any files so any modifications made to the file would not be read in by the browser.

key	meaning
java.home	Java installation directory
java.class.path	Java classpath
user.name	User account name
user.home	User home directory
user.dir	User's current working directory

Table 6-2. System Properties Not Available To Applets

6.2.2 Network Access

Netscape Navigator 2.0 allows an applet to connect only to the host from which it was downloaded. No other network connections are allowed by the security policy implemented.

6.2.3 Security Preferences

In Netscape Navigator 2.0, users have the option to disable Java functionality completely. This option is located under Netscape's Security Preferences. If this option is chosen, applets will not be downloaded and run by the browser. Netscape provides the strictest security policy for Java applets on the Internet.

6.3 Sun's Applet Viewer

The Applet Viewer is a Java application developed by Sun Microsystems that allows applets to run without using a World Wide Web browser like HotJava or Netscape. It is part of Release 1.0 of the Java Developer's Kit. Since the current version of the HotJava (alpha 3) browser is not compatible with the Java 1.0 version of the JDK, applets created with the JDK cannot be run from the browser but can be run using the applet viewer application.

In addition to the security policy implemented by the browser, the applet viewer contains some user controlled security features. These are described in detail below.

6.3.1 Applet Viewer Properties

The Network Properties function of the Applet Viewer Menu Function allows a user to change (and set) the security settings for the applet viewer. The applet viewer properties allow a user to specify the hostnames and port numbers for an HTTP proxy and Firewall proxy. The Network access option controls where a downloaded applet is allowed to connect. The user can select from one of three choice:

- None - an applet is not allowed to connect anywhere.
- Applet Host - an applet is only allowed to connect to the host from which it came.
- Unrestricted - an applet is allowed to connect anywhere.

The Class access option controls an applets ability to access class libraries. A user can select from one of two choices:

- Restricted - an applet is only allowed to access those class libraries on the local file system.
- Unrestricted - an applet is allowed to access any class libraries.

6.3.2 File I/O Security

Applets are allowed to read files that reside in the directories on the access control lists. If the file is not on the client's access control list, then the applets cannot access the file in any way. By default, the access control list for reading is null. Applets can be allowed to read directories or files by naming them in the **acl.read** property in the ***~/.hotjava/properties*** file. The variable **acl.read** is a colon-separated list. Allowing an applet to read a directory means that it can read all of the files in that directory, including any files in any subdirectories that might be below that directory. In addition, applets are allowed to read system properties by invoking ***System.getProperty(String key)*** (see Table 6-1).

Unlike Netscape Navigator 2.0, the appletviewer can prevent applets from viewing system properties by redefining the property in the ***~/.hotjava/properties*** file. For example, to hide the name of the operating system, you would add the following line to the ***~/.hotjava/properties*** file:

- os.name = null.

Applets are allowed to write files that are named on the access control list for writing. By default, the list is empty. Applets can be allowed to write files by naming them in the **acl.write** property in the ***~/.hotjava/properties*** file.

7. Security Vulnerabilities In Java Enabled Browsers

Several weaknesses and vulnerabilities have been discovered in the HotJava, Netscape Navigator 2.0, and Sun AppletViewer browser implementations. This section will describe the security flaws that exist with each of the browsers.

7.1 Security Flaws in HotJava

The HotJava browser (Version 1.0 alpha 3) has many implementation flaws which render it insecure [3]. It does not have a well-defined security policy making it subject to denial of service and man-in-the-middle attacks. In addition, HotJava applets can learn and send out important information about the machine and its user. Until recently, the HotJava browser remained in the Version 1.0 alpha 3 state. Sun Microsystems has made available the HotJava browser Version 1.0 preBeta 1 which works with the current release of the JDK and is expected to correct all the problems that currently exist with the alpha version. The remainder of this section describes some of the vulnerabilities in detail.

7.1.1 Covert Channels

Typically an applet is only allowed to connect to the host from which it was loaded. However, as a result of implementation errors, this security setting is not strictly enforced, thus allowing an arbitrary host on the Internet to connect to a HotJava browser, as long as the location of the browser is known. For this type of attack to work, the applet must signal the external attacker to connect to its port. Several covert channels exist for sending out this type of message. If the Web server from which the applet was downloaded is running an SMTP mail daemon, the applet could potentially connect to it and send an e-mail message to any machine on the Internet. Other channels include the use of the Domain Name System (DNS) and the retrieval of URL information.

7.1.2 Information Available to Applets

The HotJava browser allows a user to control File I/O access by creating a read and a write access lists. However, by default the access lists are not very restrictive. The HOTJAVA_READ_PATH contains the user's **public_html** directory, which may contain some information that compromises the privacy of the user. The Windows version allows writing in the \TEMP directory, thus allowing an applet to potentially corrupt files in use by other Windows applications. Additional information that can be obtained are the user's login, machine name, as well as other environment variables (e.g., PATH). This information can then be sent out to an interested attacker via the scenario described in the previous section.

7.1.3 Denial of Service

Although difficult to prevent, the HotJava browser is subject to denial of service attacks. There is nothing in place to prevent an applet from busy-waiting to consume CPU cycles, allocating large amounts of memory until the system runs out, creating thousands of windows, or starving threads and system processes by creating high priority threads and processes. In addition, the HotJava browser itself can be forced to crash.

7.1.4 Man in the Middle

This last type of attack involves changing the browser's FTP and HTTP proxy servers. By establishing a set of false proxies (as a man in the middle), the browser can be tricked into redirecting all traffic to the false proxies. The false proxies are then in a position to watch and edit all traffic to and from the HotJava browser. This type of attack works because sensitive information is stored in public variables in public classes.

7.2 Security Flaws in Netscape's Navigator 2.0 and Sun's JDK 1.0.

Two significant security problems[6] in implementations of the Java Applet Security Manager and Class Loader have recently surfaced. The vulnerabilities are present in Netscape Navigator's 2.0 Java implementation and in Release 1.0 of the Java Developer's Kit from Sun Microsystems, Inc. First, these implementations do not correctly implement the policy that an applet may connect only to the host from which the applet was downloaded. Second, these implementations do not correctly implement the policy that an applet is restricted to loading applets from the directories specified in the environment variable CLASSPATH.

7.2.1 DNS Attack

The Problem

As described in Section 3, an applet is allowed to connect only to the host from which the applet has been loaded. However, this restriction has not properly been enforced in Netscape Navigator's 2.0 Java implementation and in Release 1.0 of the Java Developer's Kit from Sun Microsystems, Inc. This vulnerability, combined with the subversion of the DNS, allows an applet to open a connection to an arbitrary host on the Internet. CERT has issued an advisory CA-96.05.java_applet_security_mgr to the internet community warning users of the potential threat.

In these Java implementations, the Applet SecurityManager (described in Section 5.4) allows an applet to connect to any of the IP addresses associated with the name of the computer from which it came. When a Java applet is downloaded over the network, the Java Applet SecurityManager makes note of the name of the computer that was used to serve the applet (i.e., Java host) and the IP address(es) associated with this computer's name. If, later on, the applet requests a network connection to a specific computer, the Java Applet SecurityManager checks the name and IP address of the computer the applet is requesting to connect to with the IP address(es) of the Java host. The Java Applet SecurityManager will only allow the applet to set up the network connection with the requested computer if an IP address match is found. By controlling a DNS server associated with the Java host, it is possible to advertise multiple IP addresses for the Java host, where one of the multiple IP addresses really belongs to a different computer, and trick the Java Applet Security into allowing a connection to a computer other than the Java host.

Java applets can maliciously connect to arbitrary hosts on the Internet, including those presumed to be previously inaccessible, such as hosts behind a firewall. Any vulnerable TCP/IP based network service can then be exploited. In addition, services and systems previously thought to be secure by virtue of their location behind a firewall can be attacked.

Solution

On March 14, Netscape released Navigator 2.01, which fixed the DNS attack vulnerability described above. It can be found at **http://home.netscape.com**. The next day, Sun released the Java Development Kit 1.0.1, which fixed the same vulnerability. It can be found at **http://java.sun.com**. In both releases, additional explicit checks have been added to the Java Applet SecurityManager restricting applets from making network connections to hosts other than the Java host.

7.2.2 CLASSPATH Attack

The Problem

As described in Section 5.3, the class loader provides a class loading capability, which allows a Java applet to load a class from the host it originated from or from the user's local file system. Normally, an applet is restricted to loading applets from the directories specified in the environment variable CLASSPATH. However, this restriction has not properly been enforced in Netscape Navigator's 2.0 Java implementation and in Release 1.0 of the Java Developer's Kit from Sun Microsystems, Inc. In both implementations, class libraries can be loaded from any readable directory on a user's file system. By placing a malicious class file and a dynamic library on the user's system, an attacker can open the system to attack.

Solution

Netscape Navigator 2.01 also fixes the CLASSPATH vulnerability described above. Release 1.0.1 of Sun's Java Development Kit fixes the CLASSPATH vulnerability. In both releases, the Java applet class loader has been enhanced to ensure that all files accessed by the class loader are subject to a complete suite of security checks.

7.3 Security Flaw in Netscape's Navigator 2.01 and Sun's JDK 1.0.1.

Although Netscape Navigator 2.01 was released to fix the security vulnerabilities described above, additional security flaws in the Java programming language continue to be discovered. Two additional significant security problems have recently surfaced. The vulnerabilities are present in Netscape Navigator's 2.01 Java implementation and in Release 1.0.1 of the Java Developer's Kit from Sun Microsystems, Inc. First, an implementation bug in the Java bytecode verifier allows an untrusted applet to generate and execute raw machine code. Second, for a specific firewall-protected configuration, an untrusted applet would be able to connect to a single specific host behind the firewall.

7.3.1 Verifier Implementation Bug

The Problem

A couple of students at Princeton University discovered a serious Java security flaw in the implementation of the Java security model that allows an untrusted applet to execute arbitrary machine code. The flaw discovered allows a malicious applet to execute through the browser any command that the user is allowed to execute on the system. This means that the malicious applet can read, delete, or corrupt the victim's files. The flaw exposes users of the Navigator Web browser to a risk of having their machine compromised. CERT has issued an advisory CA-96.07.java_bytecode_verifier to the internet community warning users of the potential threat.

Solution

This problem has been fixed in Netscape Navigator 2.02 and JDK 1.0.2.

7.3.2 URL Name Resolution Attack

The Problem

A software engineer from Sprint discovered a flaw that allows an untrusted applet to connect to a single specific host behind a firewall. This problem only exists from a specific firewall protected network configuration. In order for this type of attack to be successful, the following must be true:

The network that is being attacked and the attacker's network must have an identical domain name, with the attacker's domain being the officially (InterNIC) registered network. Although this configuration is unusual, all networks that fit this description are vulnerable.

Solution

This problem has been fixed in Netscape Navigator 2.02 and JDK 1.0.2.

8. Blocking Java at the Firewall

The Internet is a prime avenue for potential intruders to attempt entry into private networks, as well as to conduct "sniffing" attacks, in which they passively eavesdrop on potentially proprietary information. One effective way to increase the security of a private network connected to the Internet is through the use of "firewalls". A firewall presents a single point of entry into a private network and, as the name suggests, has the intended effect of shielding private networks from the scores of potential intrusions from the Internet.

8.1 General Java Service Flow

As described in Section 3.1, an applet is an interactive program written in the Java language, which can be loaded over the network and executed inside a Java enabled browser. Retrieving Java applets from the Internet involves two interactions. First, the HTML page referencing the applet must be downloaded into the web browser and parsed so that the browser can make the determination to retrieve the applet. Figure 8-1, shows such an enabling document written in HTML.

Once the enabling document is downloaded and parsed, the browser gathers the remaining parts of the page, including the .gif image and the Java code identified by the <applet> tags in the HTML. In the example shown in Figure 8-1, the browser would load an applet with the URL ftp://xxx.com/hackapps/HackApplet.class. The **.class** extension is automatically appended to the code name when the applet is downloaded. After retrieving the applet code, the Java-enabled browser will begin executing the binary image.

```
<img src=skull.gif
Loading of malicious applet
<applet
codebase="ftp://xxx.com/hackapps"
code=HackApplet
height=100 width=300>
</applet>
```

Figure 8-1. An Enabling HTML Document

8.2 Alternatives for Blocking Java

The general-purpose nature and complexities of the Java programming language do not allow a firewall to determine if an applet is hostile or not. Analysis by the firewall of the true effects that an applet will have on a host machine is impossibly complex. Therefore, blocking Java is essentially a binary operation; either Java is passed through a firewall or it is blocked.

Two alternatives for blocking the delivery of Java through a firewall are readily observed based on the Java service flow. First, the <applet> tag can be filtered by the firewall so that no browser will ever receive an indication of a Java applet from an enabling HTML document. Secondly, the **.class** extension can be filtered out. A final blocking option not readily apparent in the service flow is based on the fact that all Java binaries begin with the hexadecimal signature `0xCAFEBABE` (often pronounced "cafe babe"). While each of these methods presents its own advantages and disadvantages, any of the methods can be used alone or in cooperation with any of the other blocking strategies to create more complete Java blocking capabilities.

8.2.1 Applet Tag Blocking

A firewall could monitor the flow of all HTML documents through it and, if an applet tag is discovered, replace the offending HTML with a simple warning to the user. Instead of receiving the potentially hostile enabling document, the browser (and user) will receive an indication that a Java applet was removed by the firewall. The browser will not receive any applet tags and therefore will not fetch any Java applets.

The basic applet tag blocking strategy does provide a basic first line of defense. Unfortunately, the complexities of HTML and the multitude of browser implementations makes it nearly impossible to parse properly all HTML in a consistent manner. If it is unclear how a browser will determine what is HTML text and what is not, it will be even more difficult for a firewall to know precisely what documents will be interpreted by a heterogeneous group of browsers as HTML. Parsing for applet tags within these HTML documents makes the process even more difficult. One can easily envision malicious pages placed on the Internet that will not only pass through certain firewall applet tag blockers but will also cause particular browsers inside the firewall to download hostile applets.

8.2.2 .class Extension Blocking

A second method for blocking Java is based on the firewall's intercepting all requests for files ending with a ".class" extension. Unfortunately, there is no requirement in the Java Virtual Machine specification that applets end with the **.class** extension. Instead, it is a widely used convention that appears to have been hard-coded into most Java-enabled web browsers. This is similar to the convention on the WWW where all HTML files end with ".html" or in DOS, where executable files end with ".EXE" extensions. While there is no specification requiring all applets to use **.class** extensions, there are currently no known methods for causing Netscape Navigator and Microsoft Information Explorer to load and run applet with any extension other than **.class**.

8.2.3 CAFEBABE Blocking

A third method for blocking Java at a firewall is to inspect all incoming files for the hexadecimal signature `0xCAFEBABE`. This approach is particularly attractive since all Java applets start with this signature. Therefore, only the first two bytes of each downloaded file need to be checked, a fairly efficient operation. No browser parsing behavior needs to be simulated by the firewall, as is required by applet tag blocking. Furthermore, the `CAFEBABE` requirement is built into the Java Virtual Machine specification, unlike the **.class** extension convention. Of course, there is a chance of non-applet files beginning with `CAFEBABE` and being blocked at a firewall. However this possibility is extremely remote, and only a minimal number of legitimate files will be falsely identified as applets.

9. Forthcoming Work

Sun Microsystems has begun work to improve the security provided by Java. The ability to use public and private encryption keys will soon be released with version 1.1 of Java. Additional areas include Signed Classes, the ***java.Security*** class, empowering untrusted code, and establishing a standard security policy for Java enabled Web browsers. Each is described below.

9.1 Signed Classes

Having Signed Classes would allow organizations to trust code downloaded from untrusted sites. The following steps would be followed:

- The user would declare a trusted entity.
- The entity would sign Java applets or applications.
- From this point, downloaded applets or applications would be verified. After being verified, the applets would be labeled trusted, and thus granted more privileges.

9.2 The java.Security Class

The Java Development team at Sun is currently working on defining a class API for implementing additional security features. The ***java.Security*** class is a complete, practical package that will integrate security functionality (i.e., authentication, encryption, digital signatures, etc) in Java applets and applications. It includes an API for implementing digital signatures, key exchange, data encryption, and secure channels. It will also be available free from Sun Microsystems.

9.3 Empowering Untrusted Code

The ability to grant additional privileges to untrusted code is also of great concern. The developers at Sun are working on slowly and carefully adding capabilities to untrusted applets. Some capabilities include: persistent storage on the client and limited, controlled network access.

9.4 Standardized Security Policy for Web Browsers

Another, more imminent, area of work is the creation of a uniform security policy for browsers running Java applets, including Netscape Communications Corp.'s Netscape Navigator, Oracle's Oracle PowerBrowser, Spyglass Inc.'s Mosaic and future licensees. Users want to be assured that they are not downloading malicious applets onto their systems. If the security provisions are too strict, users will be limited in the types of applications they can develop. And if different browser vendors implement different security policies, the user base for Java applets will become split.

10. Conclusion

Java is an exciting enabling technology that brings dynamic and interactive capability to the World Wide Web. Much of the excitement comes from its ability to allow programmers to create and compile code that can be executed on multiple platforms. With Java, Web servers can transmit more than just static HTML data to client users. They can transmit small programs (i.e., applets) that when combined together on the client's machine can produce full-fledged interactive applications, thereby making the Web "come alive." However, before users will consent to bring over executable code from untrustworthy sources, they want to be assured that the code will not do anything malicious.

The Java language has a series of built in security precautions that help ensure that downloaded code won't be destructive. In addition, the security policy implemented by the Web browser can further restrict what an applet is allowed and not allowed to do. But is this enough? Java is fairly new and has only been available for inspection for about a year, so there will be bugs and problems. They will most likely get fixed as soon as they are found. Unlike other programming languages, Java has not had time to prove itself. The flurry of recent problems with security shows that Java is not yet safe from hackers and other would-be bandits. As a result, many companies lack the confidence and are hesitant to use this new technology.

In the near future (i.e., probably Release 1.1), Java will provide features for signing code using public-key encryption. The use of digital signatures as a mechanism for verifying the code that comes from a trusted source will play an important part in determining the future of Java. The greatest threats will come from bugs in the code, policy enforcement, and browser implementations. As for now, Java can be used to develop secure distributed applications that will run behind a firewall protected environment. Since a user can't tell which pages have applets, organizations can mandate that users only use non-Java aware Web browsers to prevent the use of external applets.

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The Future Evolution of Web Searching: Towards Distribution

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1. Abstract

Current web search services are, for many applications, remarkably effective and useful. Further, their effectiveness will improve as they evolve, and particularly as web-sites increasingly involve themselves in the indexing process. Still, the current centralized model of web search services has fundamental scaling limitations. In addition, there is the growing problem of selecting among multiple search services. In this paper, we explore the pros and cons of the centralized model versus a distributed model. We find that the distributed model, while its viability is uncertain, can not only potentially solve the problems of the centralized model, but may enhance the overall environment for searching the web.

2. Introduction

To say that the current batch of web searching services (Alta Vista, Lycos, etc.) has improved the usability of the web is a gross understatement. The web searching services have qualitatively (as well as quantitatively) changed how the web is used. This statement requires no additional explanation --- the reader need only think briefly about his or her use of these services. Or, put another way, 30 million queries per day can't be wrong.

In spite of this tremendous success, some qualifications to the above statement are called for. First, large as the web is, it only just scratches the surface of what information is and will become available. In a larger context, the current web search services cover just a fraction of what's out there (though not yet on the web per se). Second, the search services have become, in the relatively short time since their birth, something of a victim of their own successes. There are a large and growing number of search services, most specializing in one thing or another. It has become difficult just to keep up with what search services are available.

Finally, the search services themselves have exacted a certain price, mainly in the load resulting from the robots that gather resources on behalf of the search services.

All of this is evolving and will continue to evolve. The web itself (and even more so the search services) is still in its early childhood. The purpose of this paper is to examine where we're at (search service-wise), where we are likely to go, and what the paths are that may (or may not) take us there.

In particular, we extrapolate from the existing search service "model" (which is, essentially, a plethora of distinct and largely non-cooperating services) and see where that leads us.

In addition, we postulate a second model and follow its likely evolution. In the alternative model, what would otherwise be distinct search services coordinate heavily (and largely automatically) to produce what amounts to a single integrated and distributed search service.

We refer to the current model (largely non-coordinating) as the centralized model and the postulated model (heavily coordinating) as the distributed model. Naturally in anything as uncertain and vague as the web searching world it is difficult to make hard statements much less predictions about anything. We argue, however, that the distributed model leads overall to a much richer environment in which 1) more information is available, and 2) a greater number of different services are available.

We should warn the reader up front that the authors have a personal stake in the success of the distributed model. Our research project, called Ingrid (loosely derived from "information grid") is to design and implement the software tools necessary to create a global, fully-distributed, fully-automatic search infrastructure. While we surely believe in and are not intentionally biasing the arguments made in this paper, our natural inclination is to view the distributed model in a positive light.

3. The Current (Centralized) Model

The term "centralized" is a bit of a misnomer, since there are a number of aspects of the current model that are distributed. The main thing that is centralized in the current model is the database, and the corresponding index, that contains the information that is searched when a user makes a query. (The index of a database is the computer data structure, usually calculated in advance, that allows the contents of the database to be searched quickly. It can be likened, for all practical purposes, to the index of a book.)

The original information (for instance, the web documents) that is the source of the database/index is of course distributed around the web. Furthermore, in the case of HTML links, the original information forms a distributed topology. It is this distributed topology that is the primary means by which the search services discover the web documents (another means being explicit notification of URLs by humans).

This process of discovery is done by a (software) process that is usually referred to as a robot (1). A robot, upon first starting up, is supplied with one or more URLs. During its operation, it builds up an ever-growing list of URLs by retrieving the documents pointed to by the URLs it already knows, extracting the URLs from them, and then in turn retrieving those documents. In addition, in the case of search engines, the robot also extracts and selects terms from the document and indexes those for later searching.

Many kinds of robots can and do exist, for instance robots that understand netnews and can extract recent mail messages, and robots that gather documents from an FTP server. In fact, one of the earliest robots (which in fact pre-dates the web and the term 'robot'), called Netfind, cleverly exploited a number internet protocols, such as DNS, finger, and mail, to gather white-pages type information about internet users (2).

Advantages of the Centralized Model

One significant advantage of this centralized model is its relatively low start-up cost. One reason for the low start-up cost is that the whole process of finding and indexing web documents is largely automatic, requiring minimal human effort. Another reason for the low start-up cost is that the whole thing can be accomplished by installing and running software at only a single site. No cooperation is needed from the web servers (those servers that contain the documents that are being indexed). As a result, a small number of comprehensive web search services are available, and a large and growing number of specialized web search services also exist.

Disadvantages of the Centralized Model

There are also a number of disadvantages with the centralized model. They can be summarized as follows:

1. They are limited by the amount of information they can store.
2. They are limited by how quickly they can process new documents or changes in existing documents. This is both because of limitations in how quickly robots can discover such changes, and because of the time it takes to generate the indexes used for searching.
3. They have very little quality selectivity (unless, like Yahoo! (3) or Lycos A2Z (4) humans become involved in screening and categorizing documents).
4. They are limited by the number of queries they can service.
5. The robots put an extra, sometimes heavy load on web servers.
6. It is difficult to know which search services to use for a given type of query or topic area.

4. Evolution of the Centralized Model

There are a number of things that can be done to ease the problems listed in the last section. Perhaps not surprisingly, they are things that tend to distribute certain aspects of the overall operation.

First and foremost, the web servers themselves will get involved in the process of document gathering and term selection, thus offloading much of this task from the search engines. There are a number of ways they can participate in this, and in fact in limited ways they are already doing so.

Current, web servers can install a file with a well-known name in their HTTP root directory called "robots.txt" (5). This file instructs the various robots (on potentially a per-robot basis) as to which documents should or should not be retrieved. The robots.txt file solves an immediate problem.
Many URLs do not point to a static document, but instead invoke a process that dynamically generates a document. The dynamic page may also contain URLs to yet more dynamic pages, resulting in an infinite chain of documents.
The robots.txt file allows these URLs to be avoided. More generally, however, robots.txt can steer robots away from documents that have little value in an index.

(Regarding the load put on web servers by robots, we should note that the majority of complaints, at least on the robots mailing list (6), are a result not of the robots of the major search engines, which are well-behaved and not so numerous, but from the many small and often experimental robots that exist. The main threat comes not from robots of search services but from the robots of personalized web agents that we can expect to become ubiquitous in the near future. The discussion in this section to some extent applies to these robots as well as to the robots of major search engines.)

Another way in which web servers currently assist search services is by putting HTML meta-tags in their documents to supply key words to the search services. This can improve the quality of term selection by search services. The use of meta-tags for this and other purposes is growing but is still somewhat ad-hoc.

Ultimately, however, we can expect the participation of web servers to improve to the point where robots never need to retrieve the actual web documents. There is currently a standardization effort underway, driven primarily by commercial vendors of web server and search products, under the auspices of the WWW Consortium (7). This standard, called RDM (for Resource Description Messages) (8), describes a format for a document digest, and a protocol for transmitting it to another system. This digest will supply relevant information about the document, such as title, author, keywords, date, document type (using MIME (9)), size, when last modified, and so on.
(Many of the ideas for this effort came from the Harvest project (10).)

These can be read by the web-wide search services in lieu of the actual document, thus cutting down on both the number of bits the search service needs to retrieve as well as on the processing the search service has to do. For a smaller search service, such as an intra-corporate service or a specialized search service, the web server could transmit new or modified digests to the search service, thus eliminating the need for probing and retrieval by the search service. This would, however, almost certainly be inappropriate for the large search services. This is because the high volume of information coming into the large search service (basically a continuous heavy stream) requires that the search service be able to control when information comes in.

Ultimately, we can expect a standard to evolve for the format of a file in a web server that can provide a digest of the contents of the entire web server. One "whole server" digest may list the URLs on the web server that should be indexed, and the keywords and other information associated with each URL. Additional "changes" digests may indicate which URLs have been added, deleted, or modified since certain dates. Thus, a search service could read the "whole server" digest upon first encountering the web server, and then later read only the appropriate "changes" digests as necessary.

The various digests described here can go far towards solving problems 2b, 3, and 5 listed above. The remaining problems, however, remain. In what follows, we discuss these problems in more detail.

Latency in Indexing Document Changes

Web-server-wide digests will allow robots to probe a given site far more frequently. For instance, currently Alta Vista can scan 10 million documents daily (11). There are currently somewhere between 1/4 and 1/2 million publicly available web servers in existence. If a robot can learn of all changes on a given web server by retrieving one moderately small file, then a large search service can conceivably ping each web server once per hour and still have more than 90% of its capacity to pull in the actual changed documents.

Other tricks can also be brought to bear, for instance setting up retrieval hierarchies, where multiple geographically dispersed robots collect the raw material, process it, and pass it on in filtered and condensed form to the central search service site (or to still other intermediate processing points). Or, the robots can keep track of which web servers change more frequently, or can know in advance which documents will change (hourly news update) and retrieve from those more frequently (apparently this is already done to some extent by Alta Vista). And so on.

The time it takes to generate the search index, then, becomes the bottleneck. Currently it takes Alta Vista one week of continuous processing to generate the index used for its searches. (The authors apologize for the disproportionate references to Alta Vista versus the other large search services. Given the competitiveness of the search service business, information about the services is not particularly forthcoming. Our knowledge of AltaVista derives from attending a talk by Alta Vista's creator, Paul Flaherty, at Interop Tokyo 95.)

An obvious approach to solving this bottleneck would be to use two indexes, one that takes a long time to calculate but is efficient (in terms of memory and processing required for a search), and another that can be calculated essentially in real time, but is inefficient by the same measures (but perhaps acceptably so because presumably it would hold much less information). Recent changes would immediately appear in the short-term index, and later appear the long-term index after it is calculated. The "basic" search (of the long-term index) would be filtered and appended by the results of the short-term index's search.

Still, we can expect difficulties. The amount of information in the world with a short expiration time is enormous. News and weather come immediately to mind. Less traditionally, people may want to search very recent email for the purpose of, for instance, keeping track of information about a given company they hold stocks in. And on an ever shorter time scale, it is reasonable to expect people to want to search for currently ongoing web chat sessions or multimedia conference calls or broadcasts on a given topic. Any given such "live" activity may change focus within a matter of minutes, thus demanding a heavy load from any search service attempting to index them in real-time.

At this point, the reader may be thinking that nobody in their right mind would go to a global search service for up-to-date weather information. They would go to a weather service. This is exactly right, and introduces a point that we cover more a bit later on. Which is, that global search services won't be able to keep up with global information, and that there will be a growing number of specialized search services.

The Other Performance Limitations --- Information Volume and Query Frequency

In the context of the centralized model, the usual approaches to dealing with memory and CPU bottlenecks --- replication, parallelization, and brute force --- apply here.

By replication, we mean simply producing multiple exact copies of the search service. These can be in one location or multiple locations, depending on whether bandwidth to the service is one of the bottlenecks to be solved. Replication applies to the problem of too many queries. Each replica receives a fraction of the query load. Replication, however, does not solve the volume problem. Each replica must contain the full database and index.

Parallelization, where multiple systems cooperate to calculate the answer to a single query, can be used to address the volume problem, though it is tricky to get it right. The simple idea is to partition the database among multiple machines, submit a query to all of the machines, and then collect the multiple answers in a single machine where they can be sorted and returned to the querying system. (The complex idea is to actually run some kind of parallel algorithm, but this is hard and hits bottlenecks of its own, such as backplane bandwidth.)

The brute-force approach is to throw the fastest processors, tons of memory, and tons of disk at the problem. This is, by-and-large, the approach taken by Alta Vista (an approach that some computer-science types scoff at, but to which Alta Vista people cheerfully admit, since it allows them to very effectively show-off their computer product line). This approach allowed them to, seemingly overnight, overtake the other services in terms of both volume and search speed. (This was true at the time. Since then, the performance gap has closed.)

The Bottom Line

In fact, however, all of the large search services use some combination of the above three approaches. And while they have exceeded the authors' expectations so far, we still maintain that they will not be able to keep up. By some measures, such as the add/delete/change latency, they already cannot particularly well keep up, and this will likely get worse. But what we are referring to here mainly is keeping up in terms of sheer volume of information.

As a result, there will be an increasing trend towards specialization, in terms of locale, topic, or community serviced. In fact, even the "global" web search services are specialized in that they only index web pages and netnews. (This may seem like a lot, but in fact less is indexed on these services than a traditional search service such as Nexus/Lexus.)

What this means is that the sixth problem listed above, that of not knowing which search service to use for a given query, will become more severe. It is this problem that we wish to discuss at some length, and will do so in Section 6. First, however, we describe an alternative --- the distributed model.

5. A Distributed Model

There are no doubt a number of possible distributed models. Here we are interested in the particular distributed model used by our Ingrid project (12), mainly because 1) we are building it, 2) we think it may work, and 3) we can't think of another distributed model that may work.

Some of the details of the inner workings of Ingrid have already been described elsewhere (13). Here we focus primarily on its (external) functionality as seen by a user.

The major components of Ingrid are:

- a distributed topology (sort of a cross between the HTML-link topology and a search index),
- a method for (efficiently) searching the topology,
- a method for adding and deleting resources from the topology.

Each resource (which could be a web document but doesn't have to be) is represented by a digest that we call a Resource Profile. The Resource Profile contains:

- the terms that are used to represent the resource (and thus can be used by a searcher to find the resource),
- information about how the resource can be found (usually a URL),
- optionally other information.

When a resource is to be added to Ingrid's topology, a distributed search of the Ingrid topology is made (automatically, by the Ingrid software) for Resource Profiles that contain matching terms. Then, links are added (again automatically) between the new Resource Profile a certain select set of the found Resource Profiles. The result is that the new Resource Profile has become part of the Ingrid topology and can now be found by subsequent searches.

From the perspective of a web administrator, there is essentially no difference, in terms of his administrative task, between indexing his web site locally and adding his web site to the Ingrid topology. In both cases, he must of course configure his indexing software to know which documents to index, and how often to (automatically) update the index. No other configuration, however, is necessary. In particular, the web administrator requires absolutely no knowledge of the rest of the Ingrid topology or of other Ingrid users. All Ingrid topology discovery and maintenance (that is, the distributed bits) is completely automatic.

To search the Ingrid topology, a user query is submitted to an Ingrid Client, which will likely be installed on a machine in the user's domain (for instance, corporate network) or on the user's desk. The user query consists of a number of terms that describe what the user is looking for (in other words, a typical query that would be made on any search engine). Note in particular that the query need not say anything about which search services should be queried, though it could.

The entire search is managed by the Ingrid Client. That is, all queries are made by the Ingrid Client, and are not forwarded or routed by other Ingrid systems. In the course of the search, the Ingrid Client executes a series of queries to Ingrid Servers --- the machines that contain Resource Profiles and that manage the Ingrid topology. Each query allows the Ingrid Client to discover Ingrid Servers that contain better and better matches. Eventually, the Ingrid Client will know about the set of Ingrid Servers that contain the best matches, and will retrieve the matching Resource Profiles.

The search, then, can be thought of as consisting of two phases (even though this can be made invisible to the human searcher). The first phase is that of searching the topology to find good individual search engines, and the second phase is that of gathering good matches from those search engines. Because of limitations in the kind of information each Ingrid Server can keep about other Ingrid Servers (for scaling reasons), the search conditions of the first phase must be simple. That is, the first phase cannot do boolean query expressions, phrase matching, "near" matching, and so on, and is not full-text. These advanced search conditions come into play during the second phase --- the gathering from the individual search engines and the final filtering at the Ingrid Client.

Advantages of the Distributed Model

The main advantage of the distributed model is that it frees the user from requiring any knowledge of the individual search services that constitute the distributed search service. In fact, in addition to directly finding matching resources, the distributed search service can be used to discover promising individual search services.

Disadvantages of the Distributed Model

Before discussing the disadvantages of the distributed model, we should make it clear that the performance of the distributed model is still unknown. As of this writing (mid-1996) we are still in the prototype testing stage. The performance of the distributed model is a research issue, and requires that we build it and test it in the field. We can, however, make some educated speculation about its expected general characteristics.

The disadvantages of the distributed model can be summarized as follows:

1. It requires that all participants install and run the appropriate software.
2. The topology management function requires that extra information (beyond that required if the server centrally indexed its contents) be stored at each server.
3. The topology management function puts an additional load on the servers.
4. The first phase of the search puts an additional load on servers (often on servers that do not themselves contain matching documents).
5. Because of the large amount of information that is effectively being searched, the distributed model requires that the query contains enough information to keep the number of matches within manageable levels.

Regarding the first point, the "evolved" version of the centralized version, where web-site generated digests are used, also requires that web sites install software. So, at "steady-state" (the point at which the large majority of sites have installed the relevant software), there is no difference between the two models in this regard. The critical difference, however, is that in the centralized case, the software can be installed piecemeal, and in increments of increasing complexity. The distributed case requires that the site install software with some minimum complexity from the start. As a result, the probability of reaching steady-state is lower in the distributed case.

The second through fourth points describe the cost, in terms of computer and communications equipment, of the distributed model on individual sites. It is premature to say anything concrete as to how this compares with the cost of "being indexed" in the centralized model, either the current or the "evolved" versions. It is likely, though not certain, that the cost of the distributed model will be higher. In particular, we are concerned with the fourth point --- the cost of the phase one search queries on Ingrid Servers.

Whether or not the cost is within acceptable bounds remains to be seen. If it is not, then the distributed model won't work and further comparisons become moot. Therefore, in the interest of getting on with the comparison, we will assume for now that both the distributed and centralized models will satisfactorily address performance.

By performance here, we include the time it takes to perform the search. Because of the first phase of searching, the distributed search will generally take longer than a search of a single centralized search service. If, however, we 1) include in our definition of search length the time it takes to formulate the query and analyze the results, and 2) consider that multiple search engines may individually be queried in the centralized case, then it is difficult to assume that one will be particularly worse than the other.

6. Qualitative Differences between the Centralized and Distributed Models

Having waved our hands about and chosen to ignore potential performance differences, we can now focus on the fundamental qualitative differences between the two models. These differences boil down to the facts that, in the centralized model, you (or, your personal search agent) must select which search services to query, whereas in the distributed case, the "selection" is part and parcel of the overall process. The corollary to this is that, if you query a single (centralized) search service, particularly one that specializes in what you are looking for, then your query doesn't have to be as carefully composed as in the distributed case, where you are effectively querying the whole Internet.

This raises the two main questions of this paper:

- For the centralized model, the question is, how can we know which search services to query?
- For the distributed model, the question is, how can we compose queries that effectively winnow down the total number of hits?

Centralized Model: How to Find the Services

For the first question, obviously the searcher will often know, through various ad hoc means, of a good search engine to use for a particular query. To the extent that a searcher tends to repeat the same sorts of queries (for instance, queries in the same topic area, or similar types of queries, such as white-pages queries) searchers will tend to know of search services that satisfy their needs.

Still, the facts remain that 1) even in the above case some potentially useful resources may be missed, and 2) often the user in fact won't know of a good search service to use for a given query.

We don't see a good solution to this problem. One approach is to maintain a list of search services, perhaps by topic (sort-of a Yahoo! for search services). Such lists exist now (for instance, the All-In-One Search Page(14) gives you a list and a single interface with which to form your query). The main difficulty here is that it is even harder to categorize search services than it is individual web resources --- both for the provider and for the user of the list. It is also time consuming and troublesome for the user to have to browse the list at all. Such an effort is not likely to be worth the trouble for most users most of the time.

Another approach is to use some kind of meta-search service --- that is, a search service that can be queried to find other search services. This service could automatically obtain digests from the individual search services about what terms are represented. For instance, the digest could list the terms it has along with the number of resources that contain that term. The meta-search service could then supply the searcher with a rank-ordered list of the search services that will most likely satisfy his query.

One example of such a system (though somewhat more complex than what is described above) is Whois++ (15), for which a pilot white pages project exists. In addition, meta-search services exist that automatically send queries to the major search services and bundle the results on behalf of the user (for instance, MetaCrawler (16)), but these do not discriminate among the search services queried. All queries go to the full list of search services. Finally, there are a growing number of more-or-less intelligent "agents" that will query multiple search services according to pre-programmed instructions from the user (Silk (17), Sulla (18)), but the user is still required, at some point in time, to select the search services. (The former reference is interesting in that it provides a mechanism for users to exchange lists of good search services for a given topic.)

The problems with the meta-search service, as we describe it above, are as follows. First, the meta-search service is a potential bottleneck, since a large fraction of all queries would go through them. To overcome this bottleneck, the meta-search servers would need to be powerful (read, expensive) machines, and would have to be replicated (read expensive again). It is not at all clear how the current economic model for "free" web search services --- advertising --- would hold up under this arrangement.Particularly since this model invites automation at the searcher's computer, there is ample opportunity for the meta-search service's advertisement (and the individual search services' for that matter) to be filtered out, or at worst watered-down by other advertisements.

Second, the "getting off the ground" problem is even more severe for this (quasi-distributed) model than for our distributed model. In particular, in our distributed model, the initial infrastructure, small and incomplete though it may be from a global perspective, is at least useful to those who have installed it (to search their own web sites). Further, the initial users can install and run Ingrid with no coordination with other users. In the meta-search service model, somebody has to commit to creating the meta-search service (in the absence of much confidence that it will get off the ground), and the initial users have to commit to the meta-search service (in the absence of confidence that it will remain a viable service). This overall lack of confidence is unlikely to result in the software implementations or standards required.

In essence, we feel that the centralized model, even taking into account its likely evolution, ultimately comes up short of solving the complete global web searching problem.

Distributed Model: How to Focus the Search

Which brings us to the second of the two main questions --- how to compose a query to produce a manageable number of good hits for the distributed case. Before discussing this, we should note that this problem is universal in any kind of information retrieval, and unfortunately isn't easy to solve. Further, many of the sorts of approaches tried by the Information Retrieval community, such as document clustering (19), cannot be applied to the distributed case for scaling reasons.

The first point we want to make is that the distributed model is in any event no worse in this regard than the centralized model. This is because in the distributed case, one at least has the option of specifying which search services the (otherwise distributed) search should be limited to. Furthermore, the distributed case significantly improves on the centralized case for the following two reasons:

* Scoping (limiting a search to a given set of servers) is more flexible than in the centralized case.
* Learning about sets of servers (to which scoping can subsequently be applied) is easier.

By way of explanation, a little background. In Ingrid, the mechanism for scoping is to include, among the terms chosen to represent a resource in the Resource Profile, additional terms that describe the scope of the resource.For instance, our prototype always automatically includes in the Resource Profile terms that describe the DNS domain of the web server containing the resource. If a domain name is selected as one of the search terms, then resources from web servers in that domain will be searched (exclusively, if the user so requests).

Or, a group of Ingrid Server administrators from a given community of interest (say, an academic society) could agree to add a specific term to all of the resources they serve that are relevant to that community. If this term is included as one of the search terms in the query, then search can be limited to resources indexed by that community. The only coordination required by the members of the community to accomplish this is to agree on what the term is. (The term will have a hierarchical component, similar to the hierarchical components of a domain name, to insure uniqueness.) In particular, the members do not even need to who the other members are. The automatic topology maintenance of Ingrid creates links between the appropriate Resource Profiles.

Further, a user can learn of good domains or special terms through the normal course of a search. For instance, say a user does a search on a given topic. The search returns a number of Resource Profiles with matching terms. Most of these may in fact not represent relevant resources, but assume that many do. Assume also that the user doesn't consider worth his time to sort through all of the irrelevant resources.

Included in these Resource Profiles are the terms that represent the resource, including the domain name of the resources' web server and any special scoping terms. The Ingrid Client that did the search can isolate the domains and scoping terms, rank order them (say by frequency), and present them to the user. As a result, even though there may be several hundreds or even thousands of individual resources, a relatively small list of domains or web servers are presented.

In the interface we built, the user can click on given domains or scoping terms he finds favorable (or regular terms for that matter, which can also be tabulated and presented to the user in rank order) and quickly and easily determine which domains and terms best represent his interests. These domains and terms can then be dragged over and added to the query terms, after which a more selective search can be executed.

Another example of the use of specialized terms to scope searches is geographic terms. Many searches, particularly classified advertising, should be limited to a specific area. Search services that specialize in this sort of thing can add terms that indicate a geographic area. A user, upon including such a term in a query, can limit a search to just those services representing a given area (the number of which may be substantial).

Global Bottom-up Distributed Categorization

A final example of specialized terms are categorization terms. Examples of such terms can be found in Yahoo!, where everything is categorized according to a hierarchical taxonomy. Assuming that authors (or others) are willing to assign documents to categories (or at least, those documents worth categorizing), including such a category in a search query will limit the number of hits.

To some extent, the same trick described above (that of including specialized terms) can be applied to the centralized case. In Yahoo!, for instance, a search can be limited to a single category. The difference, of course, is that in the distributed case the search will cover multiple search services, not just one as in Yahoo!. In fact, a Yahoo!-like interface could be built as an application on the Ingrid infrastructure. A search at a given category would yield not only resources within that category, but also sub-categories within that category. As a result, the tremendous added-value of Yahoo!-like categorization can be achieved on a much greater scale, at much greater levels of detail and specialization.

A somewhat vague but very intriguing aspect of this categorization on a distributed search infrastructure is the possibility of a grassroots, cooperative categorization process. Such a search infrastructure would provide a forum for the bottom-up categorization process. There would exist a feedback process by which 1) people categorize their own resources, 2) other people learn of the categorizations based on their searches of the infrastructure, and 3) those people extend and enhance the available categories, suggest different categories, or assign the same resources to additional categories by creating their own Resource Profile for the resource.

Such a global cooperative categorization effort is much less likely to happen in the centralized model. In the distributed model, any categorization effort anywhere automatically contributes to the whole. Somebody searching on a given category can find all of that category's sub-categories. In the centralized case, categorization that takes place in the context of one search server will not automatically migrate to that of another search server. Thus, the categorization efforts of different people will not easily or naturally contribute to the whole.

8. Summary and Conclusions

In this paper, we have described the current, centralized model for searching the Internet, its problems, likely solutions to those problems, and the problems that will in spite of those solutions. In particular, we find two basic limitations:

- Keeping up with the scale of the Internet, both in terms of information volume and timeliness.
- Knowing which of multiple search services to use for a given query.

We describe an alternative, distributed model for global Web searching. This model has the potential for overcoming the basic limitations of the centralized model. It also opens up the intriguing possibility of greatly enhancing the searching environment of the Internet by allowing for cooperation towards classification of resources at the grassroots level. There are, however, many open questions about the viability of the distributed model. These questions can only be answered by continued research and experimentation. The Ingrid project is such an experiment, and we invite all interested parties to download our software and join in the experiment.

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REGULATORY STRUCTURE AND ITS IMPACT ON THE TELECOMMUNICATIONS SECTOR AND ECONOMIC GROWTH[1]

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1. ABSTRACT

The international telecommunications industry has experienced unprecedented growth and dramatic changes during the past decade. Numerous studies have shown that lack of improvement in the telecommunications market will have an deleterious impact on its local economy. And if the developing countries in the Asia-Pacific Region just sit back and wait, they will stand to lose more than their share of telecommunication markets.[2] These countries, nonetheless, have intelligent but difficult choices on how to remove their barriers to market entry selectively and succeed in benefitting not only their telecommunications sector but also their economy.

2. CHANGING MARKETPLACE THREATENS THE ENTRENCHED MONOPOLIST

The demand for telecommunications services and the supply of telecommunications capacity have increased dramatically, with the demand generally staying ahead of supply. The international traffic continues to grow faster than the number of lines. Even though the total international traffic is expected to grow 58% between 1995 and 2000, the number of fixed main lines is expected to increase only 25% to 850 million fixed main lines. This growth has placed substantial pressures on the infrastructure of the OAs to build new lines to cover the demand.

Whether measured in terms of revenue or traffic volume, the industry is expected to continue to grow rapidly for the foreseeable future. Annual growth in industry revenues is expected to be maintained in the 10-15% range through the year 2000. At an average rate of 13%, this means that annual revenues should practically double to over US$90 billion by the end of the century. The volume of international traffic is expected to grow even more rapidly, at about 17% compounded annually.

Growth in the international sector has been fueled by a number of factors, including regulatory liberalization, technological advances, declining costs, competition, increased globalization of business, and economic growth in emerging economies. Unrelenting economic forces have led to an explosion of opportunities for many competitive service providers, both large and small. On the other hand, the Operating Authority ("OA") or Public Telecommunications Operator[3] ("PTO") in the developing countries has the most to lose from its current business provisioning plain old telephone services ("POTS") in the new economic environment unless it focuses on liberalizing and re-regulating its telecommunication services. The Asian-Pacific governments for least developed countries must decide whether to continue to protect the status quo or move with the wave of spectacular growth of the telecommunications industry in more open markets.

Many OAs in the developing countries already have substantial backlogs in servicing its business customers. In some Asian-Pacific countries, it takes several months and several thousand dollars for a business telephone line to be installed. In some countries, it takes over a year to install a single line.

The imbalance between demand and supply is not the only impetus to wrest the control of the market from the monopolists. There are the growing alternative telecommunication methodologies that will obviate the circuits of the monopolies; and, as a consequence, the international switched voice traffic volume for the OAs could be decreasing marginally over time as new technologies take a foothold in the marketplace.[4] Alternatives to the PSTN include wireless local loops, alternative calling procedures, satellite transmissions, privately financed cables, cable television, dedicated circuits/private networks, and the Internet. These new technologies provide a wealth of opportunity to outside providers. Meanwhile, the monopoly service provider has become aware of the attrition that the new technologies has had on its basic telephony services. In Zimbabwe, for example, the OA refused to allow a local company to install a wireless local loop and battled for three years to derail the service.[5] Whether the entrenched monopolists should pursue these traditional methods to restrict new services will discussed later on.

The Internet is one example of this type of technology competing with POTS. The Internet telecommunications system consists of data packed switched services, accessed by leased data lines and switched by very high speed routers. Meanwhile, software technology has made it possible to send voice of the same data network.[6] Although the quality has not yet matched the standard voice circuits, Internet voice prices will erode the lower end of the market where price elasticity is an issue.

This alternative calling procedure reduces the revenues for a lesser developed country in that the collection revenue will drop in the drastic change of traffic flows. In Taiwan, for example, about 50% of outgoing calls were callback origination.

Lesser costs for Internet traffic is due, in part, to its Open Network Architecture. Internet's backbone is a combination of Internet Service Providers ("ISP") interconnected by high capacity leased lines. Each ISP delivers or receives traffic from the other. This framework is substantially different from the telephone carriers where ownership of facilities is paramount to survival and allows it to control its networks and corresponding costs.[7] The ISP has the further advantage in that it is not restrained by regulatory schemes, tariffs, interconnection fees, and international settlements for handing off international traffic. These additional costs are reflected on the pricing of voice telephony by carriers, while the pricing for standard voice transmission includes the development of toll quality, to which the industry has invested considerable capital and engineering over the past hundred years.

The Internet will not replace international telephony, in the short term, on account of quality problems with this service. Internet voice has a quality threshold. The reasons for its limitations are various. Internet voice uses substantial compression algorithm that requires delay and frequency demodulation of voice patterns, which will impact the trueness of the speech pattern. A portion of the algorithm also places substantial reliance on high speed modems and computers. The second issue is software compatibility - the sender and received should have both compatible hardware and software. The final is capacity. With its Open Data Network architecture, the Internet's original design was to find various means to reach its destination in packets, regardless of the route taken.[8] Each packet has a specific addressing scheme, describing its source, sequence and destination. If part of the original network is eliminated, the packet will still seek its destination. But the Open Data Network architecture has a major disadvantage: it cannot grow its capacity if everyone were to use the Internet for voice and data, because the bandwidth may be limited in its scope and requires advance planning to augment its bandwidth for each leg of the Internet circuit.

Despite its shortcomings, Internet Telephony will definitely erode market share for many carriers. With the spectacular growth of Internet voice users in 1995 from 400,000 to 16 million by the year 1999[9], the zero sum game will reveal that the monopolists need to readjust their market position in order to maintain growth.

International dedicated lines or private networks for international companies are also growing rapidly in response to high demand. International businesses which rely substantially on telecommunications are focusing on minimizing their costs by placing them under a single management source. The trend has been from the heavy and expensive reliance of dedicated access to a mixture of PSTN and dedicated access services described in the industry as the Virtual Private Network. ("VPN") The U.S. has the mature market in this arena with sales of $3.6 billion in 1995, rising to $5.5 billion by 2005.[10] The dramatic growth is outside of the U.S. where forecasts show sales of $7.9 billion over that same period from the $100 million last year in all of Europe and Asia-Pacific.[11] The VPN uses a combination of technologies from fiber optics through frame relay technologies. In some cases, VPN can also access the public switched networks, and still be cost effective without relying on dedicated lines. The frame relay technologies, for example, compress the signals for both voice and data. And the technology allows the same network to combine both services.

VPN market does face substantial hurdles in the mosaic of worldwide regulatory schemes. Licensing for its services is not transparent in many cases, in the form of arbitrary or restricitve local regulations. Local country requirements for presence, such as the creation of a local company to order local loops, can be expensive for the level of service being supplied.[12] These barriers reflect anti-competitive behavior by monopoly or dominant carriers in many countries. Nonetheless, VPN will continue to grow as part and parcel of international telephony. Clearly, this service is eroding the market share in voice telephony for the traditional international carriers.

Other services also include the growing presence of satellite and wireless services. New privately held satellites are providing bandwidth under the Ku frequency to provide international communications at cost effective prices. The dishes measure less than 2 meters and are capable of providing duplex transmission for many multinational corporations that seek integrated international telecommunication networks. Orion is typical of the new providers that service its customers with turnkey private network operations for multinational companies. Besides cellular service, wireless telephony can be set up for local loop access at substantial discount to wire based infrastructure. Cable television can also provision both telephony and cable services through wide band wireless networks.

Another service that is impacting the revenue streams of many Postal Telephone and Telegraph Operators ("PTT") are alternative calling procedures which includes refile, hubbing, and callback or call re-origination. As regional markets have deregulated and prices in those markets drop, arbitrage opportunities have developed for international telephone minutes. Smaller companies have created access methods to alternative networks to take advantage of the new opportunities, such as callback services, international simple resale, and refile. These smaller players are competing directly with the local monopolies, and the competition places pressure on the monopoly providers to reduce prices.

Currently the callback industry is generating about $600 million this year.[13] The largest callback operator, USA Global Link, with revenues of $167 million, expects to grow to $1 billion by the year 2000. These revenues impact the economic transfers normally earned by the foreign monopoly operators. Callback service provisioning has precipitated severe criticism by many countries.[14] Even the International Telecommunications Union has joined the fray by its condemnation of callback services.[15] In view of the fact that the market is expected to be worth at least $2 billion by 1998, it may be valid concern.

Various countries have attempted to block callback. Some scramble back the Dual Tone Modulation Frequency ("DTMF"). Others block the area code from which the callback operator is switching. OAs have been reluctant to lower their international tariffs fearing that it will lower the overall revenues, particularly for those that have a franchise to rollout new services under auction, such as Venezuela's CANTV or Argentina's Telintar. The most effective cure against callback is the lowering of the international tariffs to match the international tariffs of a callback hub, such as the United States. For example, Saudi Arabia has deemed it illegal to sell callback services for the last two years, but this year it reiterated its position but backed it up with lower international tariffs.

Where the monopoly telecommunication operators are being assailed by the new technologies, the worldwide marketplace is placing pressure on the old style vanguard to open up their markets. Additional pressures come from among the service providers: increased competition among the major providers which has resulted in the international alliances such as Atlas-World Partners, Global One, Concert and Unisource; an international consensus led by the FCC that international telecommunication prices must come down, which places pressure on those providers that have not shared the view; and finally, price declines in various markets, which, with the technical means described earlier, open new arbitrage opportunities that places further pressure on prices in monopoly markets.

3. LIBERALIZED AND PRIVATIZED TELECOMMUNICATIONS MARKET PLACE HAS A POSITIVE IMPACT ON THE NATIONAL ECONOMY

There is a well recognized economic tenet that liberalized economies outperform centrally planned economies. One recent study even suggests that the faster a state liberalizes its economy, the faster will its economy grow after the transition from a controlled environment to a laissez faire status.[16]

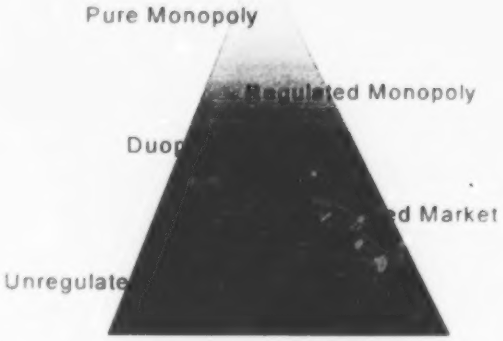
Similar conclusions have been drawn in the area of telecommunications. Telecommunications infrastructure is perceived by economists as an input to the productive process.[17] Therefore, a comparison can be made with telecommunications density and Gross Domestic Product/Gross National Product to correlate these variables in the scheme of telecommunications development. However some critics have pointed out that although studies suggest that telecommunications add to economic well being, it has been questioned whether the density does precede economic improvement. It may well follow development or come in tandem; there has been only inferential analysis. But the same criticism indicates that tariff policies should be more amenable to encouraging demand for the services, which will in turn increase the economic benefits of telephony in the infrastructure.[18]

Nevertheless a preponderance of statistics support a bi-directional causality, i.e., a change in the number of telephones caused economic growth and a change in economic growth caused a change in the number of telephones.[19] The marginal investment in telecommunications infrastructure stimulates economic growth disproportionately to its investment.

The following Table 1 demonstrates the minimum hypothesis: there is a strong correlation between the GNP and teledensity -- the number of lines per hundred people. Further, as the economy moves into the service sectors, telecommunications plays a vital role in service sector.[20] Better infrastructure raises productivity and lowers production costs. The infrastructure capacity must expand in tandem with economic output.[21] Thereby the economic growth should not be hampered by the lack of telecommunications infrastructure.

With these considerations in mind, governmental policy should look into where its telecommunication industry lies in the continuum of market access, and at which point in the pyramid of choices does the government wish to move in its progress to liberalization and privatization to reach the level of economic equilibrium.

In the following drawing (Drawing 1.) one can identify the levels of market access from the minimalist through the most open markets. A "pure monopoly" denotes a closed market where every service, whether wireless data to basic voice belongs to the province of the monopolists. The monopoly in Vietnam, for example, has closed access to any player so far. The "basic monopoly" may have control over voice, whether wire based or cellular, but may allow some market access in the wireless data or private networks. The "duopoly " market has two sizeable players. Resale may be permitted there, as well as Value Added Services ("VAS") using switching equipment interconnecting with



Drawing 1

DEMOGRAPHICS and TELEDENSITY

Country	GNP	Lines/100	Population (Millions)	Lines
India	350	0.60	849.50	5,074,734
China	370	0.60	1,133.70	6,850,300
Kenya	370	0.76	24.20	183,240
Indonesia	570	0.60	178.20	1,069,015
Philippines	730	0.99	61.50	610,032
Colombia	1,260	7.48	32.30	2,414,726
Thailand	1,420	2.37	55.80	1,324,522
Turkey	1,630	12.29	56.10	6,893,267
Costa Rica	1,900	10.05	2.80	281,433
Chile	1,940	6.52	13.20	860,075
Malaysia	2,320	8.86	17.90	1,585,744
Argentina	2,370	9.56	32.30	3,086,964
Mexico	2,490	6.21	86.20	5,354,500
South Africa	2,530	9.23	35.90	3,315,022
Venezuela	2,560	7.59	19.70	1,494,776
Brazil	2,680	6.26	150.40	9,409,230
Korea, Republic	5,400	31.02	42.80	13,276,449
Spain	11,020	32.31	39.00	12,602,600
Singapore	11,160	34.67	3.00	1,040,187
U.K.	16,100	44.20	57.40	25,368,000
Australia	17,000	45.54	17.10	7,786,889
U.S.	21,790	54.53	250.00	136,336,992
Germany	22,320	37.71	79.50	29,981,000
Sweden	23,660	68.01	8.60	5,848,700
Japan	25,430	44.15	123.50	54,523,952

Source: World Bank Statistics (1994)

the public voice switched network. Australia as an example has two liberalized carriers: Telstra and Optus. After these carriers, there are a wide variety of resellers providing services - whether data or voice - and they can interconnect with the PSTN. The U.S. falls into a "regulated restricted market" as the FCC regulates the market. There is more than one facilities based carrier and there are no limits as to the number of carriers. However, there are foreign ownership restrictions and the U.S. has restrictions to market entry -- the equivalency litmus tests, barring foreign owned carriers approaching the U.S. market. Finally, there is the "unregulated unrestricted market" which basically is a market where there are virtually no rules. Anyone can enter into that market. The pyramid suggests that one can move from the top down into the wide variety of choices that a government can choose from in liberalizing and privatizing its telecom market.

4. THE KEY TO LIBERALIZED, PRIVATIZED MARKETPLACE IS A WELL STRUCTURED REGULATORY INSTITUTION

The market is demanding a shift in its regulatory paradigm from where it has been when it managed a monopoly institution into a transparent regulatory process. What is perplexing for the developing countries is that in order to "liberalize" its telecommunications market, it often must create a regulatory body which did not exist before.

And why regulate telecommunications? Once a telecommunications market is privatized and liberalized, the market requires a traffic cop. New Zealand, as an example, hardly regulates its telecommunications sector. Critics indicate that the monopoly has applied its market power to the detriment of new entrants.[22] Where no regulation is left to the marketplace, the dominant carrier becomes the defacto regulator. Its infrastructure becomes the stick to which all the new entrants must answer to through the use of interconnection standards.

Further, it does not follow that whenever there is elimination of service barriers to entry that acceleration of innovation and service diversity would result. How should it then regulate? The underlying rationale for regulation is to set a policy in favor of the public weal that establishes a level playing field for the providers. The true basis for telecommunication regulations is based on macroeconomic principles.

An economist, formerly with the Federal Communications Commission, believes that competition is highly dependent on the type and quality of industry structure that emerges from the policies and regulations of the regulatory body.[23] And the critical factor that determines that policy is found in the market's size and existing diversity. Therefore, the type of regulatory framework is essentially relative to the size and diversity of the market. No predefined regulatory is absolute.[24] It could easily be that the market may be too small to support competition. For example, in 1994, the voting populace of Uruguay was asked to determine whether Antel, the Uruguayan PTT, should be privatized, as its neighbor Argentina had done with its telecommunications carriers. The population rejected the proposal wholeheartedly. Uruguay has a population of 3.1 million, with a GNP that places it in the upper middle income group. Its market may have been too small to support competitive markets. Ancillary issues may be that privatization may have involved foreign investments and this policy would not be acceptable to the public.[25] Political infrastructure could also be an issue in instances where labor unions or a strong political party may have lobbied against the privatization program.[26] Even today France Telecom encounters substantial interference from the strong labor unions as it prepares for the lowering of the barriers in 1998. It is patently obvious that the complex issues of privatizing a company that is in constant view of the public eye can be daunting. It is a difficult process for any recently elected political body to make a courageous decision to privatize and liberalize its telecommunications sector.

5. FUNDAMENTAL POINTS TO REGULATORY GUIDELINES

Once a developing country has jumped into the pool of liberalization and privatization, it must re-regulate its telecommunications sector in order to reap the benefits of competition and innovation. It must first set its mission with an agenda on achieving its objectives. Its mission can be as broad as fulfilling "universal service".[27] Or establish and regulate telecommunications service while protecting the "public interest". Then the administrative body should set its agenda by following fundamental regulatory goals:

1. Create a regulatory environment that fosters long term investment;
2. Enforce effective measures to prevent the abuse of monopoly powers;
3. Set up an independent institutional authority;
4. Establish regulations that are transparent and available to the public;
5. Outline the licensing terms and conditions;
6. Pick effective tariffing rules, such as the price-cap approach;
7. Detail licensing elements that encourage interconnectivity and access.[28]

These are common denominators that would fit under any country's regulatory scheme that would develop the appropriate conditions for competition in the telecom sector. A key to regulation is information. Without transparency, new players cannot identify the rules of the game. Not having the regulatory body regulate standards and interconnectivity would create hurdles for any new entrant to access the monopoly's infrastructure. These issues are prerequisites to attract foreign capital. Yet approximately 80% of all developing countries have not yet begun to restructure their telecommunications sector under these guidelines which would attract foreign investment.[29]

Yet with all of the rules discussed so far, the regulatory institution must remain flexible to changes in the marketplace for technologies change and the markets must remain competitive. The FCC has historically spurred new services based on its actions such as the inward direct distance dialing data transmission, international In-WATS service, and so on.[30] New regulatory institutions cannot remain staid without losing the advantages of competition, which should generate the innovations in the marketplace.

6. HOW CAN DEVELOPING COUNTRIES PROGRESS INTO LIBERALIZATION

Assuming that the initial tenet is correct that privatization and liberalization is good for the economy, then it should follow that the governments must implement a plan to develop its telecommunications market. Various countries phase in the liberalization process slowly: by phasing its monopoly into a more competitive environment. Some countries prefer the stance of the creation of a duopoly as in Australia and the U.K.[31] Others, such as New Zealand, open the floodgate and permitted any carrier into its border. In Latin America, Chile privatized its two carriers and allowed them to operate for a number of years prior to inviting other carriers to enter the market.

Another form of market entry is to define the services that may be offered by third parties. In the European Community, the focus was to liberalize the markets for terminal equipment and for newly emerging telecommunication services.[32] This means that Value Added Services and data communications were to be unshackled from the restrictions by the local authorities. The previous Table 1 indicated that this form of liberalization is effective with smaller players that do not have the capital to build substantial infrastructure and falls in line with the demand for new technologies such as the Internet.

In Latin America, both Colombia and Brazil allow value added services to be provisioned outside of the monopoly. However, the Colombian VAS provider is permitted to install facilities, such as satellite dishes and microwave towers, by the Brazilian VAS provider could only use the equipment of the monopolist. Colombian VAS license holders were robust, exceeding 30 providers in 1996. Meanwhile, the Brazilian VAS providers were far fewer in proportion to the population and teledensity.
VAS holders are more palatable to the establishment in the developing countries. More often than not, the VAS provider will be providing services that the local monopolist has not developed. It is more incumbent for the local authorities to permit the VAS applications prior to opening its markets to facilities based carriers.

Therefore market access can be advanced through the granting of additional licenses to competitors or by permitting gradual competition in services as in the European Community.

Market. No approach is perfectly applicable as it varies with the telecommunications market in the country. But given today's marketplace, it seems that the competition for services is more attractive to developing countries in a variety of ways. It is more acceptable to the old guard and advances the new tools found in the Internet.

7. CONCLUSIONS

Prior discussions indicate that the developing countries should begin to consider opening its markets for competition assuming that the market size and diversity justify competitive entry. In tandem with this evaluation, it may have to choose the process to liberalize its markets, or to state it another way, to re-regulate its market. Whichever route the developing country may take, it is likely it will benefit its economy in the long run.

The choice is simple: privatize its telecom sector or fall behind. The choices to the established telecom monopoly sound Cassandra-like. Yet every country which has followed the road to liberalization has reaped economic rewards, as proven earlier.

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Outsourcing and the Telecommunications Management Network

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The International Telecommunications Union's Telecommunication Management Network (TMN) framework may be viewed as an interlocking set of business processes which flow throughout a telecommunications carrier. The outsourcing of information technology functions takes on a new perspective when examined with the "business process" TMN in mind. Using this method, dramatic improvements in operational efficiency have been demonstrated, resulting in higher corporate earnings and greater availability of funds for capital expenditure.

Introduction -- *Achieving New Efficiencies in Telephony Operations*

The development of future integrated multi-service networks, driven by ongoing deregulation decisions, globalization, and increasing customer demands, is reflected in an extremely complex telecommunications management environment. The amount of capital required to expand networks and provide advanced services is beyond the reach of even large entities. This has forced many carriers to rethink their approach to administration, maintenance and certain non-core management functions.

As a result, outsourcing is making inroads in the telecommunications industry.

I. Introduction to Outsourcing

When corporations first began to adopt outsourcing in the late 1980s, it was the lure of cost savings that prompted most companies to turn over corporate functions to outside specialists. Since then, outsourcing has evolved into much more. Today, companies are either outsourcing or considering outsourcing for almost every non-core function within their business, and with a far more strategic view than ever before.

And, it shows no signs of slowing down. More than anything else, outsourcing brings a totally new role to a corporate function. Transforming its managers from service deliverers to brokers and facilitators of needed services. Successful corporations are becoming knowledge-based organizations -- setting objectives, collecting strategic information, identifying future needs and directions, developing the overall architecture and, of significant new found importance, managing relationships. Most of today's corporate functions are quickly becoming "internal systems integrators" focused on bringing together the needed resources to support the corporation's core competencies and customer needs. These corporate functions can no longer afford to spend the lion share of their time dealing with the day-to-day management of the individual pieces.

But the question remains, what are the factors to consider in making the right choice about outsourcing? The factors that contribute to success in outsourcing fall into three distinct but interrelated categories. The first set of factors have to do with the reasons for the company's decision to consider outsourcing -- that is, what are the organizational objectives? The second is the criteria, and ultimate skill, used in selecting a vendor. The third is the organization's understanding of outsourcing's critical success factors.

Outsourcing can take many shapes within an organization. Some functional areas currently being outsourced include:

a) Administration.
The areas most commonly outsourced today (in descending frequency of mention) are: printing and reprographics, mailroom, and consulting and training. The areas companies are most frequently considering for outsourcing tomorrow are: records management, administrative information systems, supply (inventory), and printing and reprographics.

b) Customer Service
The commonly outsourced functions include: field service, field service dispatch, and telephone customer support. The areas they are looking at outsourcing tomorrow are: telephone customer

support, customer service information systems, and field service dispatch.

c) Marketing and Sales

Marketing and sales outsourcing has most often been done with the following functions: direct mail, advertising, and telemarketing. Additional areas under consideration are call center operations, and field sales.

d) Information Technology

The largest area for outsourcing continues to be information technology. And, under the information technology area, the areas most likely to be currently outsourced are: maintenance/repair, training, applications development, consulting and reengineering, and mainframe data centers. The information technology functions companies are most frequently considering for outsourcing are: client/server, applications development and maintenance, networks, desktop systems, end-user support, and full I/T outsourcing.

How much are companies outsourcing?

The number and diversity of outsourcing contracts continue to grow and the forecast for the industry is explosive. The total annual expenditures for outsourcing by US organizations forecasted for 1996 by The Outsourcing Institute is $100 billion dollars (not including outsourcing, or sub-contracting, of manufacturing). Of this, fully 40 percent, or $40 billion dollars, is for information technology outsourcing.

Why Companies are Outsourcing and Related Factors

While companies still outsource for tactical reasons, the top reasons companies are outsourcing today is for strategic reasons. The top ten reasons companies outsource listed from most often to the least often mentioned are:

1. Improve company focus
2. Access to world-class capabilities
3. Reduce and control operating costs
4. Resources not available internally
5. Free resources for other purposes
6. Accelerate reengineering benefits
7. Function difficult to manage/out of control
8. Make capital funds available
9. Cash Infusion
10. Share risks

But what implications does outsourcing have for telecommunications carriers? How can they take advantage of strategic outsourcing, gain efficiencies and position themselves to compete in this rapidly changing industry? Let's examine the structure and function of IT within a telephone company to aid in answering these questions.

II. The Telecommunications Network Management Framework

The Telecommunication Management Network (TMN) is defined by ITU-T (formerly CCITT) to be a support network that provides necessary network operations and management functions in multi-vendor environments. There are many aspects of the TMN, including models, standard interfaces, TMN standards activities, distribution of network management functions, implementation architectures/products, internetworking, and specific TMN applications such as management of SONET, Rings, subnetworks, VOD services, integrated ATM and SONET/SDH networks, etc.

The importance of TMN was recognized by the European Technical Standards Institute (ETSI), Committee Telecommunications 1 (T1) in the United States, and two Japanese groups. As a result, TMN is seen globally as the basis for the management of today's and tomorrow's telecommunications networks.

Historically, the TMN framework has been discussed only in network management circles. But that is undervaluing the importance brought forth by this enterprise-wide model. The TMN is not just a description of IT architecture with data objects that can be passed from layer to layer and from module to module. This is not a science fiction story and the TMN does not define an automated "super-machine" that will run a complete telephony carrier enterprise without intervention. There are human beings and human processes at every step. From the context of outsourcing, information technology and network operations, the TMN can be viewed from this broader perspective. That is, individual layers of the TMN are seen as a series of business processes, each contributing to the overall operation of the enterprise, not just the network.

Let's examine the structure of the TMN and view its complex interrelationships and dependencies as they apply toward the business of telecommunications.

Telecommunications Network Management Framework

FIGURE 1 (See separate page)

Beginning with the bottommost layer, the following describes functionality.

1. The **Element Layer** provides for alarm detection and reporting, diagnostics and implementation of controls and commands from the Element Management Layer.

   The business, or human process that this encompasses is troubleshooting, maintenance and field repair.

2. The **Element Management Layer** provides for command and control of elements on an individual or subsystem basis. History, current status and links into Network Management, through mediation, are envisaged.

   The business, or human process that this encompasses is troubleshooting, preventive maintenance and element trending.

3. The **Network Management Layer** provides a complete view of the network within its domain. Interacts with the Element Management layer for service activation and assurance. Acts as a repository for all information gathered by the lower layers. Maintains data about network performance, usage and availability.

   The business, or human, process that this encompasses is managing the operational quality of the telecommunications services offered by the carrier.

The previous layers are all "backward-facing" or back-office operations. The final two layers are "customer-facing" or front-office operations.

4. The **Service Management Layer** supports customer management and settlements as well as management of services.
   The business, or human, process that this encompasses is managing the customer relationship, from initial sale & service activation to billing dispute resolution and revenue collections. Bill and settlements processing are included.

5. The **Business Management Layer** supports the whole enterprise, including planning, marketing decision support and goal setting.

   The business, or human, process that this encompasses is the management of the enterprise, from assuring customer satisfaction to growth planning & fulfillment.

III. Typical Outsourcing of Telephony Operations

Outsourcing and telecommunications operations are no strangers. Billing functions, such as rating, invoice preparation, stuffing and mailing, as well as data center administration are being performed by specialist companies around the world everyday. While this is just one process element of the TMN, its effects are quite noticeable.

A recent survey of large wireless operators has resulted in the following information coming to light:

Outsource?	No	Yes
Billing Costs as % of Total Revenue	6.66%	7.05%
Annual Billing Cost Per Subscriber	$53	$44
Market Penetration	4.76%	7.02%

Note 1: data is averaged across population matrices.

While outsourced billing expenses (as a % of revenue) are slightly more than in-house production, the 47% net gain in market share coupled with 17% lower overall billing costs per subscriber yield a significant advantage in revenue growth, overall cost reduction, and capital investment which can be directed toward mission-critical core requirements.

Just what are "mission-critical core requirements"? A recent survey conducted by the Telecommunications Managers Association of Great Britain ranked, in order of importance, the following considerations when choosing a telecommunications carrier.

FIGURE 2 (See separate page)

57% of all respondents named Quality of Service as the single most important criteria when selecting a telecommunications carrier. Price and Features tied for second with 11% share each. Customer Service (6%) nearly tied with Trustworthiness (5%). Technical Support and Account Management quality were tied with 3% and Strategic Support was last with 2% of the respondents. To put it another way, Quality of Service is:

> *5 times more important than Price or Features;*
> *9.5 times more important than Customer Service;*
> *11.5 times more important than Trustworthiness;*
> *19 times more important than Technical Support or Account Management;*
> *28 times more important than Strategic Support.*

Given this information, why wouldn't a carrier then wish to outsource Customer Care, along with Billing and Data Center Administration? Then they could focus on providing a higher Quality of Service (QoS) guarantee to their customers.

One TMN Layer 2 aspect still to be addressed is the customer service call center. The call center is a direct link to the customer base. Some of the criteria used to determine call center quality are: 1) immediate responses to calls without having to wait on hold, navigate through complicated menu options, or deal with inefficient representatives; 2) software applications should put various databases within easy reach of the navigational tools used by customer service representatives; and 3) the technology choices must be able to accommodate business expansion.

Truly, it takes a special kind of expertise to identify and implement all of the human, technological, and business factors that will provide the most efficient, responsive call center. Some management aspects of call center operations include:

1) staffing, workforce management, and call volume forecasting.

2) understanding evolving AIN architectures, relational databases and ACD/IVR/VRU technologies,

3) in-depth knowledge of the customer care and billing application as well as service offerings, tariffs and dispute resolution techniques.

The requirement for specialized expertise justifies outsourcing call center operations.

With regard to Point Of Sale, isn't retail distribution through third party stores a form of outsourcing? They bring their own expertise, customer base and management, providing in return a greater market share along with improved focus on core operations.

Coincidentally, this represents the final process block in the Service Management Layer. We have discussed Billing, Data Center Administration, Customer Care and Point Of Sale.

We propose that the entire Service Management Layer could be outsourced if a truly competitive and customer-focused operation is desired.

Revisiting the reasons for outsourcing, we can see the following:

1. **Improve company focus**
   The focus should be on providing world-class QoS, not bill production, call center staffing or data center operations.

2. **Access to world-class capabilities**
   Telecommunications companies are the best at telecommunications. Information technology companies are the best at IT issues.

3. **Reduce and control operating costs**
   It takes expertise and experience to run efficient IT organizations.

4. **Resources not available internally**
   Money can be spent to hire the talent or subcontract the process.

5. **Free resources for other purposes**
   Management should direct their energies on the revenue-producing side of the enterprise. Let subject matter experts handle cost reductions.

6. **Accelerate reengineering benefits**
   The outsource partner becomes a part of your reengineering.

7. **Function difficult to manage/out of control**
   Who ever said that data center operations were easy?

8. **Make capital funds available**
   This is a test: You can either (a) build, staff, train and manage a data center, or (b) buildout your network to reach another 10,000 subscribers. Which do you choose?

9. **Cash Infusion**
   In cases where the outsource partner assumes an existing operation, cash may generated as part of that sale.

10. **Share risks**
   Risk sharing leverages the power of many companies, not just yours.

Given the power of outsourcing to unleash the telecommunications enterprise from mundane and non-core tasks, what other layers of the TMN may be addressed? Is it possible to gain even more efficiencies by directing our examination elsewhere?

IV. Facilities Maintenance

This is the domain of the telecommunications operator and its' internal maintenance staff. Historically, the Element and Element Management Layers are strictly the purview of the PTT or private carrier. Or are they?

If we look at this area with a view toward outsourcing, we can see technological developments that have revolutionized how networks are maintained. The most noticeable is digitalization. Digital networks do not require constant maintenance, as opposed to their analog counterparts. However, they do need a highly skilled, trained workforce properly equipped with the latest in test & troubleshooting equipment and available on demand. Additionally, the use of modern trouble ticketing and dispatching systems allow efficiencies of operation to be realized.

In fact, network maintenance is an excellent candidate for subcontracting as exemplified by the most successful and profitable US airline, Southwest Airlines. All of their aircraft maintenance is performed by 3rd party contractors. As a result, Southwest is able to concentrate on providing the best service at the lowest price and they have never had a crash in their entire 25 year history. Telecommunications companies can benefit as well.

Hughes Network Systems, the largest VSAT network provider in the world, has outsourced its maintenance. Communications Central Inc. (CCI), the US's second largest independent pay telephone operator, signed a 10-year contract for the outsourcing of the phone company's field service and management information systems functions. Maintenance outsourcing really does work!

V. Network Management - The Final Frontier

Network management (NM) represents a critical factor in customer satisfaction and, hence, is mission-critical to the core business. However, there are two perspectives to NM - business management and technical management. Clearly, the domain of the telephone service provider is management of the business, but what of the technical aspects? As competitive pressures increase, the demands on network management continually mount. Some of the challenges:

1. Ensuring appropriate levels of service quality and performance.
2. Supporting an increasing number of services with ever greater requirements.
3. Assist in making increasingly complex decisions about financial, technical, organizational, and geographic needs.
4. Managing tactical vendor relationships and offerings.
5. Reducing time to implementation of new services.
6. Keeping sufficiently skilled resources available in sufficient numbers and controlling the cost of keeping their skills up to date.

In view of these challenges, the network operator must have the most knowledgeable technical staff. It could make the difference between growing market share and yielding position to competitors. At the same time, the carrier must keep costs under control.

According to a recent survey of CIOs by Deloitte Touche, outsourcing of maintenance and network management, the core functions of the information services department, continues to grow. Over the last three years, CIOs have become increasingly willing to outsource their core functions. Many CIOs are planning to evaluate the outsourcing of network management in particular. CIOs frequently cited difficulty in supporting client/server systems and advanced networks as a major issue and appear to be more willing to look outside their own ranks for the needed skills. Thirty one per cent of the respondents said their companies were currently outsourcing these functions, and 24% were evaluating outsourcing. This is an increase from 27% reporting outsourcing in 1993 and 22% evaluating outsourcing last year.

Certainly, care must be exercised when outsourcing all or part of network management. Some guidelines when selecting an outsourcing partner in this realm:

1. Proven experience in managing domestic and multinational networks.
2. Availability of a powerful pool of skilled personnel.
3. Proven ability of implementing the most advanced technology.
4. Outstanding reputation in conducting business.
5. Willingness for revenue sharing.
6. Fair employee transfers.

VI. Beyond Outsourcing - Strategic Consulting

Advance up the TMN framework, up from Layers 4, 3 and 2, you arrive at the pinnacle of mission-critical core elements, Business Planning. While we do not advocate an outsourcing position with respect to this area, there are certain functions which demand specialized expertise. Marketing and planning decisions require the analysis of useful data generated internally as well as external databases and information resources. Extracting, interpreting and evaluating useful data from the massive volumes of information available is called data mining.

Data mining refers to using a variety of techniques to identify nuggets of information or decision-making knowledge in bodies of data, and extracting these in such a way that they can be put to use in the areas such as decision support, prediction, forecasting and estimation. The data is often voluminous, but as it stands of low value as no direct use can be made of it; it is the hidden information in the data that is useful.

There are several steps in data mining. The phases depicted start with the raw data and finish with the extracted knowledge:

Selection - selecting or segmenting the data according to some criteria. In this way subsets of the data can be determined.

Preprocessing - this is the data cleansing stage where certain information is removed which is deemed unnecessary and may slow down queries. Also the data is reconfigured to ensure a consistent format as there is a possibility of inconsistent formats because the data is drawn from several sources.

Transformation - the data is not merely transferred across but transformed in that overlays may added such as the demographic overlays commonly used in market research. The data is made useable and navigable.

Data mining - this stage is concerned with the extraction of patterns from the data. A pattern can be defined as given a set of facts (F), a language (L), and some measure of certainty (C). A pattern is a statement (S) in L that describes relationships among an Fs subset of F with a certainty C such that S is simpler in some sense than the enumeration of all the facts in Fs. In other words, looking for meta-data, or data within the data.

Interpretation and evaluation - the patterns identified by the system are interpreted into knowledge which can then be used to support human decision-making e.g. prediction and classification tasks, summarizing the contents of a database or explaining observed phenomena.

The total process is called "decision support". Decision support provides a means to manage multiple plans in parallel, rapidly shifting from one plan to another in response to business changes. It provides instant results for "what if" and "what now" analyses.
The complexity of the decision support process mandates an aptitude for gathering information, managing databases and manipulating extraction tools. Strategic consultants provide these skills and work within the carrier to leverage all available resources toward maximizing revenue and market share while cutting costs and inefficiencies.

VII. Conclusions

Global deregulation, technology advances and sophisticated customers are driving carriers to achieve new levels of performance. Their IT processes can be viewed using the ITU-T's Telecommunications Management Network framework as a set of building blocks. Any combination of blocks can be outsourced to take best advantage of resources and introduce new efficiencies (cost reduction). Capital can then be directed at marketing and new service introduction programs (revenue generation). Meanwhile, administration and network operations are performed with a guaranteed level of quality and fixed cost.

Naturally, this can only be accomplished by a very sophisticated company - preferably one with wireline and wireless experience coupled with a long history of outsourcing. One who understands the unique needs of telecommunications carriers and has entered into partnerships the world over.

Before deciding for or against outsourcing, consider carefully these Top Ten Criteria:

1. Quantify present costs of people, equipment, and communications. Not only the present status, but the satisfaction of future needs has to be quantified prior to the outsourcing decision.

2. Analyze existing human resources, instruments, and processes in order to decide which functions may be considered appropriate for outsourcing. Analysis may result in substantial savings in operating expenses (35%), in staff reduction (25-50%), and in a network budget's stabilization.

3. Determine the service grade required by users and applications. Perhaps the outsourcing company should even be solely dedicated and not share its resources among multiple clients.

4. Availability of skilled network management personnel is one of the most critical issues, most frequently, it's the only driving factor for outsourcing.

Outsourcing should not be implemented if cost reduction is the only motivating factor. Rather, outsourcing is a strategic endeavor that will position the telecommunications operator for growth in the competitive world of the 21st century.

Telecommunications Contracting Out for Industry Development
A South Australian Experience

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1. ABSTRACT

In a region where the economy has been traditionally based on agriculture, mining and manufacturing, it is South Australia's aim to revive the economy, in particular by the growth of the information industries. There are now real signs that the IT base in South Australia is growing, and we are establishing a major export focused IT presence in the Asia Pacific region.

South Australia has attracted major global players into the region through a variety of strategies. One key strategy, and the subject of this paper, has been leveraging of public sector information technology and telecommunications outsourcing to achieve industry development. The success of this strategy is now being recognised, and increasingly there is evidence that the contracting out of IT services not only results in significant cost savings to the government, but more importantly, becomes a tool for attracting major global players and ensuring flow-on benefits to the local industry.

South Australia's experiences in dealing with major telecommunications companies will be of benefit to other countries in the Pacific Rim who are currently also recognising the importance of information enriched telecommunications to the future of their economies. In a world where exports will be increasing reliant on being visible in the global network, small, less-central countries will be disadvantaged less by geographic location and more by the lack of preparedness to embrace the information age. The establishment of telecommunications infrastructure, whether digital cables, satellites, cellular or mobile radio is only one part of the story. Access to cost effective services, and world leading technology to the wider community will be a key differentiator.

2. BACKGROUND

2.1 REVIVING THE ECONOMY

South Australia is aiming to boost its economy by broadening of the economic base, in particular by creating substantial growth in information industries. South Australiais IT2000 Vision, which was developed early in 1994, aims to build the information industries sector, establishing the State as a recognised centre of information industries excellence in the Asia Pacific Region.

2.2 THE IT2000 VISION

The Vision declares that by the Year 2000, South Australia will be recognised internationally as -

a leader in at least 5 information industries niches;
a key software and services centre for the Asia pacific region;
a pace setter for the 'whole of government' approach to the contracting out of the IT based reform of public sector operations; and
an early example of an information empowered society.

This integrated strategic plan is unique among Governments at any level in Australia and was developed not just because the information industries sectors are a major growth area, but because they are also crucial in improving the competitiveness of other key sectors of the economy.

2.3 THE NICHE AREAS

The most effective way to broaden the state's information industries base is to target niche areas that offer competitive advantage. To date, the main focus has been on 6 niche areas:
software: the fastest growing segment of the information industries ;

multimedia : poised to be the next boom area;
spatial information: South Australia already has proven leadership in geographic information systems;
online services: the future way of doing business;

IT education: the government, industry and education sectors are collaborating to provide first class IT education for South Australia and for export;

operations support: South Australia is successfully attracting multinational company support services and 'back office' centres.

The IT2000 Vision is supported by industry cluster analysis work where Government and industry are working together to define the requirements for sustainable world-class industry in the nominated niche areas for the State. This is ensuring we build on local industry capability in many other areas of the information industries in a process that includes evaluating our local capability and skills, and undertaking gap analysis, leading to development of strategies for:
collaboration;
co-location of like companies;
industry leader supports services; and
targeted industry attraction.

There are now real signs that the Government is building a strong IT&T base in the State of South Australia, and establishing a major export focused IT presence in the Asia Pacific region.

2.4 PROGRESS TOWARDS 2000

In the two years since the development of the IT2000 Vision for the state, key strategies and projects have been put in place to ensure that the State has a strong foundation on which to build for the future.

Already 2000 new jobs have been created in the information industries sector and the State is positioning itself to take advantage of the way in which telecommunications is transforming the globe.

Strategies to ensure the availability of low cost telecommunications are seen as critical to the future of the State. This paper addresses, in particular, those strategies involving whole-of-government telecommunications outsourcing and the associated economic development benefits created for South Australia.

3. CONTRACTING OUT IN SOUTH AUSTRALIA

3.1 PUBLIC SECTOR IT&T

South Australia has attracted major global information companies into the region by leveraging outsourcing of public sector information technology and telecommunications to achieve industry development objectives. The success of its strategies is now being recognised, and increasingly there is evidence that the contracting out of IT services not only results in significant cost savings to the government, but more importantly, becomes a tool for economic development major global players and ensuring flow-on benefits to the local industry.

The first major whole of government contracting out initiative was the awarding of a contract for the South Australian Government's entire data processing to Electronic Data Systems (EDS). This is the first time in the world data processing has been contracted out on a whole-of-government basis and it is estimated it will lead to savings of AUD100m over the life of the contract.

3.2 INDUSTRY DEVELOPMENT IMPACT

As well as ensuring the significant presence of a major industry leader in South Australia, the EDS contract has resulted in substantial industry development opportunities for the State and also gave EDS an opportunity to establish a major base in the Asia Pacific region.

Some of the industry development commitments from the contract include:
Establishment of the EDS Asia Pacific Resource Centre in South Australia;
Establishment of an Information Management Centre for EDS (a key management node on its global network) - one of three only in the world;
Establishment of an Information Processing Centre in South Australia - one of only 15 in the world;
EDS contribution to Playford Computer Enterprise Centre to provide enterprise level support to local industry to enable them to compete in export markets;
Creation of Channels to Asia Program for marketing of local products in the Asia/Pacific region;
Creation of 1000 jobs in South Australia addition to those transferring from government;
Consolidation of General Motors' Australian processing in South Australia.

EDS,Telstra, Silicon Graphics, Motorola, Tandem and Microsoft are just some of the global players that have established a significant presence in the State - some as a result of leveraging 'whole of government' outsourcing, others through targeted investment attraction. And estimates have put the growth of the State's multimedia industry over the last two years at greater than 100% per year, following the development of creative precincts for the city's new multimedia set, in close proximity to cultural and learning institutions.

4. TELECOMMUNICATIONS

4.1 KEY DIFFERENTIATORS

South Australia recognises the importance of telecommunications cost competitiveness to the future economic success of the State

A recent study of Adelaide's cost effectiveness has revealed that Adelaide, the capital city of South Australia, has a cost advantage compared with other major Australian and Asia Pacific population centres such as Sydney, Melbourne, Singapore, Hong Kong and Kuala Lumpur in:
industrial and CBD rentals;
industrial and commercial properties;
port costs;
professional services;
labour costs; and
energy and water charges.

Accordingly, Adelaide offers a competitive advantage to companies that are intensive users of labour; to industries that require large industrial sites; and to those industry sectors that are relatively intense users of water and gas and electricity.

4.2 TELECOMMUNICATIONS AS A DIFFERENTIATOR

There is no doubt that South Australia's economic success in the twenty first century will depend on local industries that can compete successfully in global markets.

In a world that is increasingly reliant on telecommunications, the Government is aware that access to cost effective telecommunications services, and the availability of world leading technology to the wider community, will be a key differentiator for South Australia in the global economy. That is, low cost, high functionality telecommunications will ensure South Australia's competitiveness in the global economy.

Consequently, the telecommunications strategies developed as part of our IT2000 Vision, are attracting to South Australia telecommunication industry leaders and companies, and operational components of companies, that are information intensive and large users of telecommunication services.

5. THE TELECOMMUNICATION STRATEGIES

5.1 ATTRACTION OF INDUSTRY LEADERS

As the global economy is transformed by telecommunications, a major barrier to growth is access to and the cost of telecommunications; the world is shrinking as the information industries makes global borders redundant.

Increasingly, IT&T is being used as a tool to increase the competitiveness of all industry, and is a significant factor in enabling non-IT industries to reach out beyond state borders. The establishment of Telecommunications Industry leaders in a significant way in South Australia is seen as a vital element in the future of the Stateis economy.

The first of the strategies set in place was the contracting out of Telecommunications Services Management (TSM) for the whole of the State Government's basic carriage requirements. The objectives of the TSM contract were:

to provide real reductions in telecommunications costs for the benefit of the Government and industry;
to ensure the successful bidders charges for provisioning were no higher than those specified in the BCS tarriffs; and
to ensure the successful bidders charges for management services were no less favourable than charges of other service providers of a substantially similar service.

The Department of Information Industries South Australia sought bids for the TSM contract from companies experienced in telecommunications provision both nationally and internationally. This led to the signing of a contract between the State Government and AAP Telecommunication, a deal worth almost $100 million over the two years of the contract.

5.2 INDUSTRY BENEFITS OF TSM OUTSOURCING

Aside from the significant saving achieved by the public sector through this process, the Government negotiated with AAPT to ensure that our industry could get access to telecommunications discounts which will greatly exceed those they could achieve through their own means.

AAPT made a commitment to provide participating industry organisations with feature rich services at the most competitive rates in the marketplace; the most competitive telecommunications rates currently available are now available to South Australian businesses as a result of this unique deal. With telecommunications being a major cost of business, particularly where export markets are being pursued, the TSM contract has given South Australian industry a significant competitive advantage.

5.3 THE AAPT CONTRACT

As from the 1st of July 1996, any registered South Australian business - small, medium or large - is eligible to buy telecommunications services at the Government's discounted rates.

In effect the Government has achieved significant competition in a regulated environment.

The TSM contract consolidates the Government's own telecommunications services, currently worth $50m a year, providing direct savings of up to AUD3m per annum over two years. Savings will almost double as a result of consolidation of accounts and services. But the most important aspect of this contract is that Government work is being used as a lever to make available better communications rates to South Australian companies.

Under the contract, SA companies have access to the lowest communications rates in Australia, providing savings of between 20% and 40% on long distance and international calls, based on standard tariffs. This will mean those companies actively working in the international market, or those seeking to break into new export markets, will have significant advantage over their competitors' outside of South Australia.

5.4 MOBILE AND FIXED TELECOMMUNICATIONS

The second prong of the strategy is to contract out all of the Government's internal communications networks, including mobile radio. A major component of this strategy is the provision to Government of a new two-way trunked mobile radio service for all Government agencies, especially emergency services such as police, ambulance and fire services. Work is currently proceeding to outsource the Government Radio Network (GRNC).

There are also plans for the outsourcing of the Government's own telecommunications infrastructure which will be used as a lever to ensure the provision of high functionality telecommunications to information intensive economic areas of the state and rural/regional areas, as well as supporting the attraction of further information intensive industry to South Australia. As a result, wide bandwidth will link key information intensive precincts in the city and its surrounding areas.

South Australia's experiences in dealing with major telecommunications companies will be of benefit to other countries in the Pacific Rim who are currently also recognising the importance of information enriched telecommunications to the future of their economies.

6. INFORMATION ENRICHED TELECOMMUNICATIONS

6.1 ELECTRONIC COMMERCE

Rosabeth Moss Kanter has analysed the key drivers for successful economic development in a range of US organisations and regions. In her report in a recent edition of the Harvard Business Review, she stresses that the 'successful organisations and regions will be those which command one or more of the intangible assets of concepts, competence and connections'.

Electronic commerce, allows organisations to focus on, and excel in, these intangibles and excel in these. And the success of electronic commerce will be built on widely available, cost effective telecommunciations services.

Conseqently, the Government's telecommunication strategies leading to lower communication costs is providing the foundation for the establishment and expansion of electronic commerce in the State.

Indeed without compelling electronic commerce, many argue that it will be impossible to compete effectively as our economy becomes more globally oriented and more reliant on information.

It is acknowledged by experts that the Internet will change the basis of competition for many companies, and many companies will disappear within 10 years as a result of not adapting to this change in time. Internet based commerce is estimated to be $150b by the Year 2000 and one million companies are expected to be offering products and services on the Internet by that time.

6.2 SOUTH AUSTRALIA ON-LINE

In South Australia, a key objective of the IT2000 vision has been the creation of an 'information empowered society'. A key strategy is the one-stop-shop being built for South Australian information and services - the 'South Australian Venue' on the Web.

Government services and information will be progressively incorporated into the South Australian web venue, providing the community with an integrated, compelling and very user friendly way to do business with the Government. Not only will it not be necessary to know which Government agency you need to deal with (boundaryless Government), it will be possible to register a motor vehicle and obtain car insurance quotes from a range of private sector companies through a single transaction!

In the future, web pages such as South Australia's 'East End Online' which enables direct ordering and delivery of goods from a variety of shops and business in a precinct of Adelaide, will become commonplace.

The State is encouraging all local businesses to seize a window of opportunity to go online as part of a wider South Australian Web Venue. Local companies are being assisted to compete directly with global suppliers. Collaboration between local businesses will be increasingly important, fuelled by low cost communication connections. There is increased opportunity to reach the consumer directly.

The success of compelling online services relies on widely available low cost telecommunciations. The South Australian Government is creating new approaches to economic development through its IT2000 strategies.

7. CONCLUSION

In summary, the Government's Telecommunications strategies have demonstrated two clear benefits in ensuring that South Australia :

is well positioned to take advantage of telecommunications developments in the 21st century;
further sharpens its competitive edge, enabling it to offer local companies and international companies a competitive edge.
Other countries in the region may wish to take note of how the outsourcing of Government could be used to leverage economic development.

In a world where economic growth will be increasing reliant on being visible on the global stage geographically distant countries will be able to overcome disadvantages of location through on-line service provision. The limiting factor is likely to be the lack of preparedness to embrace the information age. The establishment of telecommunications infrastructure, whether digital cables, satellites, cellular or mobile radio is only one part of the story. Provision of cost effective, world leading services to the wider community will be a key differentiator for regions in the global economy.

The South Australian Government has successfully used outsourcing as an invaluable tool in attracting and retaining the information industry key players required to embrace the information age for a competitive future.

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